

Unison GPS

Network Time Server



User Manual

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Preface

Thank you for purchasing the Unison Network Time Server. Our goal in developing this product is to bring precise, Universal Coordinated Time (UTC) into your network quickly, easily and reliably. Your new Unison is fabricated using the highest quality materials and manufacturing processes available today, and will give you years of troublefree service.

About EndRun Technologies

EndRun Technologies is dedicated to the development and refinement of the technologies required to fulfill the demanding needs of the time and frequency community.

Our innovative engineering staff, with decades of experience in the research and development of receiver technology for the Global Positioning System (GPS), has created our window-mount GPS antenna and extended hold-over oscillator-control algorithms.

The instruments produced by EndRun Technologies have been selected as the timing reference for such rigorous applications as computer synchronization, research institutions, aerospace, network quality of service monitoring, satellite base stations, and calibration laboratories.

EndRun Technologies is committed to fulfilling your precision timing needs by providing the most advanced, reliable and cost-effective time and frequency equipment available in the market today.

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About This Manual

This manual will guide you through simple installation and set up procedures.

Introduction – The Unison, how it works, where to use it, its main features.

Basic Installation – How to connect, configure and test your Unison with your network.

Client Set-Up – Two sections; one for Unix-like platforms and one for Windows NT/2000/XP.

Console Port – Description of the Linux console commands for use over the network and serial ports.

If you detect any inaccuracies or omissions, please inform us. EndRun Technologies cannot be held responsible for any technical or typographical errors and reserves the right to make changes to the product and manuals without prior notice.

Warranty

This product, manufactured by EndRun Technologies, is warranted against defects in material and workmanship for a period of three years from date of shipment, under normal use and service. During the warranty period, EndRun Technologies will repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to EndRun Technologies. Buyer shall prepay shipping charges to EndRun Technologies and EndRun Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to EndRun Technologies from another country.

Products not manufactured by EndRun Technologies but included as an integral part of a system (e.g. peripherals, options) are warranted for ninety days, or longer as provided by the original equipment manufacturer, from date of shipment.

Extended Warranty

The MTBF (Mean Time Between Failures) for this product is 225,000 hours (25 years). After the initial warranty period it is most cost-effective for the customer to repair the unit on an “as needed basis”, rather than pay for an extended warranty or the annually recurring fees of a service contract..

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. ENDRUN TECHNOLOGIES SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Warranty Repair

If you believe your equipment is in need of repair, call EndRun Technologies and ask for a customer service agent. It is important to contact us first as many problems may be resolved with a phone call. Please have the serial number of the unit and the nature of the problem available before you call. If it is determined that your equipment will require service, we will issue an RMA number. You will be asked for contact information, including your name, address, phone number and e-mail address.

Ship the unit prepaid in the original container or a container of sufficient strength and protection to EndRun Technologies. EndRun will not be responsible for damage incurred during shipping to us. Be sure the RMA number is clearly identified on the shipping container. Our policy is to fix or repair the unit within 5 business days. If it is necessary to order parts or if other circumstances arise that require more than 5 days, an EndRun service technician will contact you.

Repair After Warranty Expiration

If the warranty period has expired, we offer repair services for equipment you have purchased from EndRun. Call and ask for a customer service agent. It is important to contact us first as many problems may be resolved with a phone call. Please have the serial number of the unit and the nature of the problem available before you call. If it is determined that the equipment has failed and you want EndRun to perform the repairs, we will issue you an RMA number. Ship the unit prepaid in the original container or a container of sufficient strength and protection to EndRun Technologies. EndRun will not be responsible for damage incurred during shipping to us. Customer is responsible for shipping costs to and from EndRun Technologies. Be sure the RMA number is clearly identified on the shipping container. After the equipment has been received we will evaluate the nature of the problem and contact you with the cost to repair (parts and labor) and an estimate of the time necessary to complete the work.

Limitation of Liability

The remedies provided herein are Buyer's sole and exclusive remedies. EndRun Technologies shall not be liable for any direct, indirect, special, incidental or consequential damages, whether based on contract, tort or any other legal theory.

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Chapter One

Introduction

The Unison is a precision server of Universal Coordinated Time (UTC) that can be connected via a 10/100Base-T ethernet port to any TCP/IP network. In its most basic operation, it sends Network Time Protocol (NTP)/Simple Network Time Protocol (SNTP) reply packets in response to NTP/SNTP request packets which it has received from clients. The timestamps it sends in its NTP/SNTP reply packets are accurate to less than one-hundred microseconds. NTP/SNTP client software is available for virtually all operating systems.

The Unison is composed of a Global Positioning System (GPS) time and frequency engine integrated with an IBM-PC compatible fanless, convection-cooled 133 MHz CPU with integral ethernet interface, RS-232 serial port and a power supply. Non-volatile storage of the embedded Linux operating system and the Unison application software is via FLASH memory.

For more detailed information that is not included in this manual, and links to other sites, please visit our website: <http://www.endruntechnologies.com>. There you can also download firmware upgrades, the latest manuals and other documentation.

GPS Timing-How It Works

The time and frequency engine in the Unison receives transmissions from satellites that are operating in compliance with the Navstar GPS Interface Control Document (ICD) known as GPS-ICD-200. It specifies the receiver interface needed to receive and demodulate the navigation and time transfer data contained in the GPS satellite transmissions. The GPS navigation system requires a means of synchronizing the satellite transmissions throughout the constellation so that accurate receiver-to-satellite range measurements can be performed via time-of-arrival measurements made at the receiver. For the purposes of locating the receiver, measurements of the times-of-arrival of transmissions from at least four satellites are needed. For accurate time transfer to a receiver at a known position, reception of the transmissions from a single satellite is sufficient.

The GPS system designers defined *system time* to be *GPS time*. GPS time is maintained by an ensemble of high-performance cesium beam atomic frequency standards located on the earth's surface. GPS time is measured relative to UTC, as maintained by the United States Naval Observatory (USNO), and maintained synchronous with UTC-USNO except that it does not suffer from the periodic insertion of leap seconds. Such discontinuities would unnecessarily complicate the system's navigation mission. Contained in the data transmitted from each satellite is the current offset between GPS time and UTC-USNO. This offset is composed of the current integer number of leap seconds difference and a small residual error that is typically less than +/- 10 nanoseconds.

Each satellite in the constellation contains redundant cesium beam or rubidium vapor atomic frequency standards. These provide the timebase for all transmissions from each satellite. These transmissions are monitored from ground stations located around the world and carefully measured relative to

GPS time. The results of these measurements for each satellite are then uploaded to that satellite so that they may be incorporated into the data contained in its transmissions. The receiver can use this data to relate the time-of-arrival of the received transmissions from that satellite to GPS time.

All of this means that during normal operation, the source of the timing information being transmitted from each of the satellites is directly traceable to UTC. Due to the nature of the GPS spread spectrum Code Division Multiple Access (CDMA) modulation scheme, this timing information may be extracted by a well-designed receiver with a precision of a few nanoseconds. The GPS time and frequency engine in the Unison does just that.

Where to Use It

Since signals from the GPS satellites are available at all locations on the globe, you may deploy the Unison virtually anywhere. However, you must be able to install an antenna either on the rooftop or in a window so that satellite transmissions may be received at least several times during the day. Once synchronized, the Unison can maintain acceptable network synchronization accuracy for about a day without GPS reception, by flywheeling on its standard temperature compensated crystal oscillator.

Because the Unison has been designed to operate in conjunction with existing public domain NTP/SNTP client software that has been created for use with similar time servers, it may be used in any computer network environment that is using TCP/IP protocols. Although client software is available for all platforms, for the most precise applications, the Unix-like operating systems are best supported.

Main Features

Performance, Reliability and Economy

The Unison provides high performance and reliability combined with low power consumption and cost. Its internal sub-assemblies are fabricated using state-of-the-art components and processes and are integrated in a solid, high-quality chassis.

Flexibility

It supports a variety of TCP/IP network protocols compatible with a variety of platforms and operating systems.

Easy Installation

Its standard 1U high, 19" rack-mountable chassis and rooftop or window-mounted antenna make installation simpler compared to competing products that require rooftop installation of the antenna. The rack-mount chassis may be mounted in any convenient location. Connect it to your network via the rear panel mounted, 10/100Base-T RJ-45 connector and plug in the AC power cord. Initial network configuration is automatic on networks using the Dynamic Host Configuration Protocol (DHCP). Manual network configuration is via the RS-232 serial I/O port and a simple Linux shell script.

Free FLASH Upgrades

Firmware and configurable hardware parameters are stored in non-volatile FLASH memory, so the Unison can be easily upgraded in the field using FTP and TELNET or the local RS-232 serial I/O port. Secure upgrades are possible via SSH and SCP. We make all firmware upgrades to our products available to our customers free of charge.

Chapter Two

Basic Installation

This chapter will guide you through the most basic checkout and physical installation of your Unison. Subsequent chapters and appendices will give you the information needed to configure your installation for the maximum performance in your operating environment. General NTP client setup instructions will also be supplied to get you started using your Unison quickly.

*Basic familiarity with TCP/IP networking protocols like **ping**, **telnet** and **ftp** is required. Though some familiarity with Linux or other Unix-like operating systems would be helpful, it is not essential. If you satisfy these conditions, the instructions provided herein should guide you to a successful installation.*

Checking and Identifying the Hardware

Unpack and check all the items using the shipment packing list. Contact the factory if anything is missing or damaged. The Unison shipment typically contains:

- Unison (part # 3017-0001-000 or #3017- variant)
- Unison User Manual (part #USM3017-0000-000)
- IEC 320 AC Power Cord (part #0501-0003-000)
(This part will not be present if using the DC power option.)
- DB9F-to-DB9F Null-Modem Serial I/O Cable (part #0501-0002-000)
- RJ-45 to RJ-45 CAT-5 patch cable, 2 meters (part #0501-0000-000)
- Antenna/cable assembly (part #0610-0006-001 or #0610- variant)

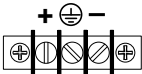
Unison Physical Description



- Sync LED** This green LED flashes to indicate synchronization status.
- Network LED** This amber LED illuminates when the Unison is connected to the network and flashes when receiving or transmitting packets..
- Alarm LED** This red LED illuminates briefly at power-up, and thereafter whenever a serious fault condition exists.



- Antenna Jack** This TNC connector mates with the download cable from the external antenna.
- RS-232 Connector** This DB-9M connector provides the RS-232 serial I/O console interface to the Unison. This console allows the user to initialize and maintain the Unison. See **Chapter 5 - RS-232 Serial I/O Port Signal Definitions** for detailed information.
- 10/100Base-T Jack** This RJ-45 connector mates with the ethernet twisted pair cable from the network.
- Alarm Jack (Option)** This BNC connector (or terminal strip) provides the optional alarm output, and is usually not installed. If installed, see details in **Appendix F - Specifications** for the Alarm output.
- AC Power Input Jack** This IEC 320 standard three-prong connector provides AC power.
- DC Power Input Block** This optional 3-position terminal block provides connection to the DC power source, and replaces the AC power input jack.



Performing an Initial Site Survey

- Using the status LED indicators, it's easy to find out if your Unison will work in your desired location:
1. Screw the TNC plug on the end of the antenna cable onto the TNC antenna input jack on the chassis rear panel of the Unison.

2. Plug one end of the supplied AC power cord into an 85-270 VAC outlet.
3. Plug the other end into the AC input connector on the chassis rear panel of the Unison.

Place the antenna in a window, or for best performance, mount it on the roof using the supplied mounting hardware. Make sure that it is not blocked by large metallic objects closer than one meter. Although the antenna should normally be installed in a vertical orientation for rooftop installations, when window mounting it should be pointed out the window, in the direction that gives the best clear view to the sky. This will improve its ability to receive signals from satellites near the horizon.

Initially upon power up:

1. The unit will light the red Alarm Status LED for about ten seconds.
2. Then it will continuously light the green Sync Status LED.
3. When the unit locks onto a GPS signal and begins to decode the timing data and adjust the local oscillator, the green Sync Status LED will flash very rapidly (about a 6 Hz rate) until the data is fully decoded and the local oscillator is fully locked to the GPS frequency.
4. Then the green Sync Status LED will pulse at precisely a 1 Hz rate, synchronized to UTC seconds, with a short on duration relative to the off duration.

At this point, the GPS time and frequency engine has fully synchronized, and you may proceed to permanently mounting the chassis and antenna in their desired locations.

If this sequence has not occurred within twenty-four hours, and you have mounted your antenna in a window or your rooftop installation has poor sky visibility, you may need to provide an accurate reference position to the unit so that it can operate with only one satellite in view. If you have mounted the antenna in a window and can easily move it to the rooftop, you should do that first. Should you need to provide a reference position to the unit, refer to *Appendix D - GPS Reference Position* and the `setgpsrefpos` command for details.

If you are unable to achieve GPS lock after trying all of these suggestions, then your Unison may be damaged and should be returned to the factory for repair or exchange.

Installing the Unison

Mount the Unison

Using standard 19" rack mounting hardware, mount the unit in the desired location. After mounting the unit and connecting the antenna cable, verify that it still acquires and tracks a GPS signal.

CAUTION

Ground the unit properly with the supplied power cord.

Position the power cord so that you can easily disconnect it from the Unison.

Do not install the Unison where the operating ambient temperature might exceed 122°F (50°C).

Connecting the DC Power Option

Connect the safety ground terminal to earth ground. Connect the “+” terminal to the positive output of the DC power source. Connect the “-” terminal to the negative output of the DC power source. Note that the Unison has a “floating” internal power supply, therefore either the positive or negative output of the DC power source can be referenced to earth ground. This unit will not operate if the +/- connections are reversed; however it will not be damaged by a reverse connection.

SHOCK/ENERGY HAZARD

Install in Restricted Access Location.

Use 10-14 AWG copper wire only.

Terminal block screw torque: 9 in-lbs (1 nM).

Branch circuit must have circuit breaker, 15A or less.

Install terminal block cover after wiring.

Connecting and Configuring Ethernet

Connect one end of the CAT-5 patch cable supplied with your Unison to the rear panel mounted RJ-45 connector labeled 10/100BASE-T. Connect the other end of the patch cable to your network through a ‘straight’ port on your hub. Do not connect it to a ‘crossover’ port on your hub.

By factory default, the Unison will attempt to configure the ethernet interface automatically via the Dynamic Host Configuration Protocol (DHCP). The Unison will attempt to set the netmask, its IP address, the IP address of the default gateway, the domain name and the IP addresses of any nameservers, if the DHCP server is configured to provide them. You may optionally configure the Unison to also set its hostname via DHCP, if your DHCP server is configured to provide it. You can do this by running a simple shell script called **netconfig** after your unit is up on the network.

If your network *does* use DHCP for host configuration, and you are in a hurry to get your Unison up and running, you may proceed to **Verifying Network Configuration** to make sure that the network parameters were set up correctly. Otherwise, it is recommended that you read the following sections on use of the RS-232 serial I/O port now, since they will help you in debugging any problems that you may encounter with the automatic configuration via DHCP.

If your network *does not* use DHCP, you will need to configure your ethernet interface using the RS-232 serial I/O port. The following sections contain brief descriptions on how to do that.

Configuring Ethernet with the Serial Port

To configure your ethernet interface with the serial port, after logging in as the *root* user, you must run a simple shell script called **netconfig** from the **bash** shell prompt. This shell script will prompt you for the needed information and perform some syntax checking on your inputs. Then it will create or modify the appropriate files needed to configure the ethernet interface. The following sections will guide you in setting up communications with the Unison using its RS-232 serial I/O port.

Connect the RS-232 Serial I/O Port

You will need to use the RS-232 serial I/O port if your network does not support the Dynamic Host Configuration Protocol (DHCP). In that case, you must be able to configure the Unison network

parameters manually using the Linux console shell interface which is provided by this serial I/O port. Under certain conditions, you may also need to use the RS-232 serial I/O port if you encounter a problem while upgrading the firmware in your Unison.

To test serial communications with the Unison you will need either a VT100 compatible terminal or a terminal emulation program running on your computer. We will refer to either of these as “terminal” for the remainder of this instruction.

1. Disconnect power from the Unison.
2. Connect one end of the DB9F-to-DB9F null modem adapter cable to the serial I/O jack on the Unison.
3. Connect the other end of the DB9F-to-DB9F null modem adapter cable to the terminal. If the serial I/O port on your terminal does not have a DB9M connector, you may need to use an adapter. Refer to *Chapter 5 - RS-232 Serial I/O Port Signal Definitions* for details on the signal wiring. *If you are using a computer for your terminal, remember which port you are using because you will need to know that in order to set up your terminal software.*

Test the Serial Port

You must configure your terminal to use the serial I/O port you used in *Connect the RS-232 Serial I/O Port*. You must also configure your terminal to use the correct baud rate, number of data bits, parity type and number of stop bits. *Be sure to turn off any hardware or software handshaking.* The settings for the Unison are:

- 19200 is the Baud Rate
- 8 is the number of Data Bits
- None is the Parity
- 1 is the number of Stop Bits

After configuring these parameters in your terminal, apply power to the Unison. After about 20 seconds, your terminal should display a sequence of boot messages similar to these:

```
*****
* 6010-0040-000 Linux Bootloader v1.00 08/17/2004 *
*****
Default root file system: FACTORY
To override and boot the UPGRADE partition type 'UPGRADE' within 5 seconds...
.....
```

These lines are the Linux bootloader boot prompt. This prompt will timeout after 5 seconds and the Linux kernel and the factory default Unison root file system will be loaded. When the Linux kernel is loaded from FLASH memory into RAM a long list of kernel-generated, informational messages is displayed as the kernel begins execution and the various device drivers are initialized:

```
Booting Linux with FACTORY root file system...

6010-0041-000 Linux Kernel v2.4.26-1 #0 Wed Aug 18 17:28:45 UTC 2004
BIOS-provided physical RAM map:
BIOS-88: 0000000000000000 - 000000000009f000 (usable)
BIOS-88: 0000000000100000 - 0000000002000000 (usable)
32MB LOWMEM available.
On node 0 totalpages: 8192
```

CHAPTER TWO

```
zone(0): 4096 pages.
zone(1): 4096 pages.
zone(2): 0 pages.
DMI not present.
Kernel command line: config=11000001 initjffs=0 console=ttyS0,19200 root=/dev/
mtdblock4 load_ramdisk=1 rw
Initializing CPU#0
Calibrating delay loop... 66.96 BogoMIPS
Memory: 30784k/32768k available (812k kernel code, 1596k reserved, 162k data, 68k
init, 0k highmem)
Checking if this processor honours the WP bit even in supervisor mode... Ok.
Dentry cache hash table entries: 4096 (order: 3, 32768 bytes)
Inode cache hash table entries: 2048 (order: 2, 16384 bytes)
Mount cache hash table entries: 512 (order: 0, 4096 bytes)
Buffer cache hash table entries: 1024 (order: 0, 4096 bytes)
Page-cache hash table entries: 8192 (order: 3, 32768 bytes)
CPU: AMD 486 DX/4-WB stepping 04
Checking 'hlt' instruction... OK.
POSIX conformance testing by UNIFIX
PCI: Using configuration type 1
PCI: Probing PCI hardware
PCI: Probing PCI hardware (bus 00)
Linux NET4.0 for Linux 2.4
Based upon Swansea University Computer Society NET3.039
Initializing RT netlink socket
Starting kswapd
JFFS2 version 2.1. (C) 2001 Red Hat, Inc., designed by Axis Communications AB.
Serial driver version 5.05c (2001-07-08) with MANY_PORTS SHARE_IRQ SERIAL_PCI enabled
ttyS00 at 0x03f8 (irq = 4) is a 16550A
ttyS01 at 0x02f8 (irq = 3) is a 16550A
ttyS02 at 0x03e8 (irq = 0) is a ST16654
ttyS03 at 0x02e8 (irq = 3) is a ST16654
sc520_wdt: CBAR: 0x800df000
sc520_wdt: MMCR Aliasing enabled.
sc520_wdt: WDT driver for SC520 initialised.
RAMDISK driver initialized: 16 RAM disks of 16384K size 1024 blocksize
pcnet32.c:v1.28 02.20.2004 tsbogend@alpha.franken.de
PCI: Enabling device 00:0d.0 (0000 -> 0003)
pcnet32: PCnet/FAST III 79C973 at 0x1000, 00 0e fe 00 00 33
tx_start_pt(0x0c00):~220 bytes, BCR18(9a61):BurstWrEn BurstRdEn NoUFlow
SRAMSIZE=0x1700, SRAM_BND=0x0800, assigned IRQ 12.
eth0: registered as PCnet/FAST III 79C973
pcnet32: 1 cards found.
Tempus SC520 flash device: 1000000 at 2000000
Amd/Fujitsu Extended Query Table v1.3 at 0x0040
number of CFI chips: 1
Creating 7 MTD partitions on "Tempus SC520 Flash Bank":
0x00000000-0x000e0000 : "Tempus kernel"
mtd: Giving out device 0 to Tempus kernel
0x000e0000-0x00100000 : "Tempus Lo BootLdr"
mtd: Giving out device 1 to Tempus Lo BootLdr
0x00100000-0x00200000 : "Tempus /boot"
mtd: Giving out device 2 to Tempus /boot
0x00200000-0x00300000 : "Tempus /logs"
mtd: Giving out device 3 to Tempus /logs
0x00300000-0x00900000 : "Tempus FACTORY rootfs"
mtd: Giving out device 4 to Tempus FACTORY rootfs
0x00900000-0x00fe0000 : "Tempus UPGRADE rootfs"
mtd: Giving out device 5 to Tempus UPGRADE rootfs
0x00fe0000-0x01000000 : "Tempus Hi BootLdr"
mtd: Giving out device 6 to Tempus Hi BootLdr
NET4: Linux TCP/IP 1.0 for NET4.0
IP Protocols: ICMP, UDP, TCP, IGMP
```

```
IP: routing cache hash table of 512 buckets, 4Kbytes
TCP: Hash tables configured (established 2048 bind 2048)
NET4: Unix domain sockets 1.0/SMP for Linux NET4.0.
mtdblock_open
ok
RAMDISK: Compressed image found at block 0
mtdblock_release
ok
VFS: Mounted root (ext2 filesystem).
Freeing unused kernel memory: 68k freed
INIT: version 2.76 booting
/etc/rc.d/rc.S: /bin: is a directory
mtdblock_open
ok
mtdblock_open
ok
Loading GPS
Fri Aug 20 00:53:54 2004 -0.707128 seconds
2004
Setting system time using hwclock
INIT: Entering runlevel: 3
Entering multiuser...
Attempting to configure eth0 by contacting a DHCP server...
```

At this point, if you do not have a DHCP server configured on your network the unit will time-out and print these messages:

```
Unison GPS DHCP Client was unable to find the DHCP Server!
Fix the problem and re-boot or set up static IP address
by running netconfig.
dnsdomainname: Host name lookup failure
(none)
```

Then these messages are printed, in either case:

```
Disabling IPv4 packet forwarding...
Starting daemons: syslogd klogd inetd
Starting the Network Time Protocol daemon...
Starting the SNMP daemon...
Starting the system logfile manager...
Starting the system watchdog...woof!
```

During this process, the factory default UnisonGPS_0 root file system is loaded from FLASH disk to an 16MB ramdisk and the remainder of the boot process completes. At this point, the Unison login prompt is displayed:

```
*****
*           Welcome to Unison GPS console on:  gnntp.your.domain
*           Tue Feb 20 2001 21:47:03 UTC
*****

gnntp login:
```

Here you may log in as “gnntpuser” with password “Praecis” or as the “root” user with password “endrun_1”. When logged in as “gnntpuser”, you may check status information and view log files but you will not be able to modify any system settings or view secure files. In order to perform system setup procedures, which includes configuring the IP network settings, you must log in as the “root” user. After correctly entering the password at this prompt,

password:

the sign on message is shown. It identifies the host system as Unison GPS and shows the software part number, version and build date:

```
Unison GPS 6010-0042-000 v 1.00 Wed May 9 14:17:44 UTC 2002
Unison GPS (root@gntp:~)->
```

This last line is the standard Unison GPS shell prompt. The Unison uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **gntpasswd** command issued from the shell prompt.

If you do not see characters displayed by your terminal program within 30 seconds after the unit is powered up, you must troubleshoot your setup. An incorrectly wired cable or incorrect port setting in your terminal emulation program are the most common problems. Refer to *Chapter 5 - RS-232 Serial I/O Port Signal Definitions* for the signal connections for the Unison.

NOTE

You must use a null-modem cable or adapter if you are connecting the Unison to another computer or other equipment configured as Data Terminal Equipment (DTE). The supplied cable is a null-modem cable.

Once you have successfully established communications with the Unison, you may proceed to configuring the network parameters. Then you can communicate with the Unison over the network using **telnet** or **ssh** and synchronize your network computers to UTC using NTP.

Using netconfig to Set Up Your IP

The following is a sample transcript which illustrates the use of **netconfig**. The entries made by the user are underlined and are provided purely for illustrative purposes. You must provide equivalent entries that are specific to your network. Those shown here are appropriate for a typical network that does not use DHCP. Start the configuration process by typing **netconfig** at the shell prompt:

```
Unison GPS(root@gntp)-> netconfig
*****
***** Unison GPS Network Configuration *****
*****
*
* This script will configure the TCP/IP network parameters for your
* Unison GPS. You will be able to reconfigure your system at any time
* by typing:
*
* netconfig
*
* The settings you make now will not take effect until you restart your
* Unison GPS, so if you make a mistake, just re-run this script before
* re-booting.
*
* You will be prompted to enter your network parameters now.
*
*****
*****
```

BASIC INSTALLATION

```
---DHCP Settings
Use a DHCP server to configure the ethernet interface? ([y]es, [n]o) n

---HOST name setting

Set the hostname of your Unison GPS. Only the base
hostname is needed, not the domain.
Enter hostname: gntp

---DOMAIN name setting

Set the domain name. Do not supply a leading `.`
Enter domain name for gntp: your.domain

---STATIC IP ADDRESS setting

Set the IP address for the Unison GPS. Example: 111.112.113.114
Enter IP address for gntp (aaa.bbb.ccc.ddd): 192.168.1.245

---DEFAULT GATEWAY ADDRESS setting

Set the default gateway address, such as 111.112.113.1
If you don't have a gateway, just hit ENTER to continue.
Enter default gateway address (aaa.bbb.ccc.ddd): 192.168.1.241

---NETMASK setting

Set the netmask. This will look something like this: 255.255.255.0
Enter netmask (aaa.bbb.ccc.ddd): 255.255.255.248

Calculating the BROADCAST and NETWORK addresses...
Broadcast = 192.168.1.247      Network = 192.168.1.240

Your Unison GPS's current IP address, full hostname, and base hostname:
192.168.1.245      gntp.your.domain      gntp

---DOMAIN NAMESERVER(S) address setting

Will your Unison GPS be accessing a nameserver ([y]es, [n]o)? y

Set the IP address of the primary name server to use for domain your.domain.
Enter primary name server IP address (aaa.bbb.ccc.ddd): 192.168.1.1

Will your Unison GPS be accessing a secondary nameserver ([y]es, [n]o)? y

Set the IP address of the secondary name server to use for domain your.domain.
Enter secondary name server IP address (aaa.bbb.ccc.ddd): 192.168.1.2

Setting up TCP/IP...
Creating /etc/HOSTNAME...
Creating /etc/rc.d/rc.inet1...
Creating /etc/networks...
Creating /etc/hosts...
Creating /etc/resolv.conf...

*****
*****
*
*           The Unison GPS network configuration has been updated.
*
*           Please re-boot now for the changes to take effect.
*
*****
```

```
*****
*****
```

Verify Network Configuration

If you have made changes to your network configuration using **netconfig**, you should shutdown the Unison and re-boot it. There are two ways to do this:

1. Cycle power to the Unison.
2. Issue the shutdown with re-boot command at the shell prompt:

```
Unison GPS(root@gntp:~)-> shutdown -r now
```

If you are using the RS-232 serial I/O port to communicate with the Unison, you will be able to see the kernel generated boot messages when the unit re-boots. You should note the line

```
Configuring eth0 as 192.168.1.245...
```

if you have set up a static IP address, or this line

```
Attempting to configure eth0 by contacting a DHCP server...
```

if you are using DHCP. It appears near the end of the kernel generated boot messages.

If you are using DHCP and are not using the RS-232 serial I/O port, you will have to check the DHCP configuration information maintained by your DHCP server to determine the expected IP address and log in to the Unison using **telnet** or **ssh** to verify successful DHCP configuration. Refer to the subsequent topics in this section *Using Telnet* and *Using SSH*, for details on logging in to the Unison that way. Once you have logged in, you may perform the following checks.

If you are not using DHCP, the IP address shown should match the static IP address which you entered during the **netconfig** procedure. If so, log in as “root” at the login prompt and check the other configuration parameters using **ifconfig**:

```
Unison GPS(root@gntp:~)-> ifconfig
```

```
eth0      Link encap:Ethernet  HWaddr 00:0E:FE:00:00:34
          inet addr: 192.168.1.245 Bcast:192.168.1.247 Mask:255.255.255.248
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3779 errors:0 dropped:0 overruns:0 frame:0
          TX packets:727 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Interrupt:5 Base address:0x300

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:3924  Metric:1
          RX packets:170 errors:0 dropped:0 overruns:0 frame:0
          TX packets:170 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
```

Pay particular attention to the settings shown for **eth0** and in particular the **Mask**: setting, which should match that which is appropriate for your network. Now check the remaining configuration parameters using **route**:

```
Unison GPS(root@gntp:~)-> route
```

Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
localnet	*	255.255.255.248	U	0	0	0	eth0
loopback	*	255.0.0.0	U	0	0	0	lo
default	192.168.1.241	0.0.0.0	UG	1	0	0	eth0

Here you are interested in the default gateway address. It should match the appropriate one for your network. If so, then the ethernet interface of your Unison has been successfully configured to operate on your network and you are ready to check operation of the Unison over the network. If not, you should re-check your configuration and/or repeat the **netconfig** procedure.

If you have configured a nameserver(s) for your network, you may check that by issuing this shell command:

```
Unison GPS(root@gntp:~)-> cat /etc/resolv.conf
```

```
search your.domain
nameserver 192.168.1.1
nameserver 192.168.1.2
```

Which displays the contents of the */etc/resolv.conf* file containing your domain name and the nameserver IP address(es) to use for that domain.

Check Network Operation

With your Unison network parameters properly configured, you are ready to test the setup using **ping** from a server or workstation that is able to access the network connected to the Unison. Alternatively, you could **ping** one of your servers or workstations from the Unison shell prompt to test the setup.

Once you have successfully established network communications with the Unison, you may perform all maintenance and monitoring activities via **telnet** and **ftp**. The Unison provides both client and server operation using **telnet**. For security reasons as well as to reduce the memory footprint in the Unison, only client operation is supported using **ftp**.

Security conscious users will want to use **ssh**, the secure shell replacement for **telnet**, as the login means. The companion utility, **scp** provides a secure replacement for **ftp** as a means of transferring files to and from the Unison. Both of these protocols are supported in the Unison via the OpenSSH implementations for Linux. Refer to *Appendix A - Security* for more information about the secure shell protocol.

Using Telnet

When establishing a **telnet** connection with your Unison, logging in directly as *root* is not permitted. This is a security measure that makes it slightly more difficult to gain access by simply trying passwords, since it is also necessary to know the name of a user. When you initiate a **telnet** session with the Unison, this banner will be displayed:

```
*****
*               Welcome to Unison GPS telnet console on:  gntp.your.domain
*****
```

```
gntp login:
```

Here you may log in as “gntpuser” with password “Praecis”. When logged in as “gntpuser”, you may check status information and view log files but you will not be able to modify any system settings or view secure files. After correctly entering the password at this prompt,

Password:

the sign on message is shown. It identifies the host system as Unison GPS and shows the software part number, version and build date:

```
Unison GPS 6010-0004-000 v 1.00 Wed May 16 14:17:44 UTC 2002
Unison GPS(root@gntp:~)->
```

This last line is the standard Unison GPS shell prompt. The Unison uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **gntpasswd** command issued from the shell prompt.

To gain *root* access, you must now issue the “super user” command at the shell prompt:

```
Unison GPS(root@gntp:~)-> su root
```

You will then be prompted for the password, which is “endrun_1”, and be granted *root* access to the system. To leave “super user” mode, issue the shell command **exit**. Issuing **exit** again will close the **telnet** session.

Using SSH

When establishing a **ssh** connection with your Unison, logging in directly as *root* is permitted. When you log in as *root* via a **ssh** session with the Unison, this banner will be displayed:

```
*****
*           Welcome to Unison GPS SSH console on:  gntp.your.domain
*****

root@gntp.your.domain's password:
```

Here you may log in as “root” with password “endrun_1”. After correctly entering the password the sign on message is shown. It identifies the host system as Unison and shows the software part number, version and build date:

```
Unison GPS 6010-0042-000 v 1.00 Fri Aug 20 14:17:44 UTC 2004
Unison GPS(root@gntp:~)->
```

This last line is the standard Unison GPS shell prompt. The Unison uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **gntpasswd** command issued from the shell prompt.

Issuing **exit** will close the **ssh** session.

Configuring the Network Time Protocol

Now that the network has been configured and tested, you may configure the operation of the NTP server. By default, the Unison is configured to respond to NTP requests from clients that may or may not be using MD5 authentication. If the clients are using MD5 authentication, they must be configured properly with the same MD5 authentication keys as the Unison. If you need to modify the factory default Unison MD5 keys (recommended) or set up broadcast/multicast operation, then you will need to re-configure the NTP subsystem. You may perform the configuration from either a **telnet** or **ssh** session, or the local RS-232 console.

NOTE

If you would like to configure your server for multicast operation, configure it as you would for broadcast operation, with the exception that you must enter this specific NTP multicast address: 224.0.1.1, when you are prompted to enter the broadcast address.

Configuring NTP Using the Network Interface or Serial Port

The following is a transcript of the question and answer configuration utility provided by **ntpconfig**. The user entered parameters are underlined:

```
Unison GPS(root@gntp:~)-> ntpconfig
```

```
*****
*****Network Time Protocol Configuration*****
*****
*
* This script will allow you to configure the ntp.conf and ntp.keys files
* that control Unison NTP daemon operation.
*
* You will be able to create new MD5 authentication keys which are stored
* in the ntp.keys file.
*
* You will be able to update the authentication related commands in the
* ntp.conf file.
*
* You will be able to configure the "broadcast" mode of operation, with
* or without authentication. If you supply the multicast address instead
* of your network broadcast address, then you will be able to configure
* the time-to-live of the multicast packets.
*
* The changes you make now will not take effect until you re-boot the
* Unison GPS. If you make a mistake, just re-run ntpconfig prior to
* re-booting.
*
* You will now be prompted for the necessary set up parameters.
*
*****
```

```
---MD5 Keyfile Configuration
```

```
Would you like to create a new ntp.keys file? ([y]es, [n]o) y
```

You will be prompted for a key number (1 - 65534), then the actual key.
When you have entered all of the keys that you need, enter zero at the next
prompt for a key number.

MD5 keys may contain from 1 to 31 ASCII characters. They may not contain
SPACE, TAB, LF, NULL, or # characters!

```
Enter a key number (1-65534) or 0 to quit: 1
```

```
Enter the key (1-31 ASCII characters): EndRun Technologies LLC
```

```
Writing key number: 1 and Key: EndRun_Technologies_LLC to ntp.keys
```

```
Enter a key number (1-65534) or 0 to quit: 2
```

Enter the key (1-31 ASCII characters): Tempus GPS

Writing key number: 2 and Key: Tempus_GPS to ntp.keys

Enter a key number (1-65534) or 0 to quit: 0

---NTP Authentication Configuration

Do you want authentication enabled using some or all of the keys in the ntp.keys file? ([y]es, [n]o) y

You will be prompted for key numbers (1 - 65534), that you want NTP to "trust". The key numbers you enter must exist in your ntp.keys file. If you do not want to use some of the keys in your ntp.keys file, do not enter them here. NTP will treat those keys as "untrusted".

Clients that use any of the "trusted" keys in their NTP polling packets will receive authenticated replies from the Unison GPS. When you have entered all of the "trusted keys" that you need, enter zero at the next prompt for a key number.

Enter a trusted key number (1-65534) or 0 to quit: 1

Enter a trusted key number (1-65534) or 0 to quit: 2

Enter a trusted key number (1-65534) or 0 to quit: 0

---NTP Broadcast/Multicast Configuration

Would you like to enable broadcast/multicast server operation? ([y]es, [n]o) y

Set the network broadcast/multicast address for the Unison GPS to use. For broadcast mode, this address is the all 1's address on the sub-net.

Example: 111.112.113.255

For multicast operation, it is this specific address: 224.0.1.1

Enter IP address for NTP broadcast/multicast operation (aaa.bbb.ccc.ddd): 224.0.1.1

You have selected multicast operation. Enter the number of hops that are needed for the multicast packets on your network (positive integer): 1

It is highly recommended that authentication be used if you are using NTP in broadcast/multicast mode. Otherwise clients may easily be "spoofed" by a fake NTP server. You can specify an MD5 key number that the Unison GPS will use in its broadcast/multicast packets. The clients on your network must be configured to use the same key.

Would you like to specify an MD5 key number to use with broadcast mode? ([y]es, [n]o) y

Enter the MD5 key number to use (1-65534): 2

```
*****
*****
*
*   The Unison GPS Network Time Protocol configuration has been updated.   *
*
*           Please re-boot now for the changes to take effect.           *
*
*****
*****
```

Configuring the Unison as a Stratum 2 Server

Operating the Unison as a Stratum 1 Server is the recommended mode. You may operate the unit as a Stratum 2 server but since there are innumerable ways to configure your network with Stratum 2

servers, specific instructions for how to do that are beyond the scope of this manual. General instructions are that you need to edit the *etc/ntp.conf* file and then copy it to the */boot/etc* directory to make it nonvolatile.

Unless you are a very knowledgeable NTP user and understand the ramifications we advise against using your Unison as anything other than a Stratum 1 server. Since the Unison is running standard NTP compiled from the distribution maintained at the University of Delaware all information in the following link is pertinent:

<http://www.ntp.org>.

Although all the information is available at the above site, the following are excellent tutorials on setting up NTP and are easier to understand:

<http://www.sun.com/solutions/blueprints/0701/NTP.pdf>

<http://www.sun.com/solutions/blueprints/0801/NTPpt2.pdf>

<http://www.sun.com/solutions/blueprints/0901/NTPpt3.pdf>

Chapter Three

Setting Up NTP Clients on Unix-like Platforms

To configure your Unix-like computer to use your Unison, you must have successfully completed the Basic Installation procedures in Chapter 2. This manual is not a 'How-To' on installing and using NTP; basic approaches to NTP client configuration for operation with the Unison will be described. It is expected that you are, or have access to, a capable Unix/Linux system administrator and know more than a little about installing distributions from source code. Installation must be performed by a user with root privileges on the system. If you have never used NTP, then you should spend some time reading the on-line documents, especially the Distribution Notes, FAQ and Configuration subject matter, which are available at: <http://www.ntp.org>

Although all the information is available at the above site, the following are excellent tutorials on setting up NTP and are easier to understand:

<http://www.sun.com/solutions/blueprints/0701/NTP.pdf>
<http://www.sun.com/solutions/blueprints/0801/NTPpt2.pdf>
<http://www.sun.com/solutions/blueprints/0901/NTPpt3.pdf>

Many problems may also be solved by the helpful people who participate in the Internet news group devoted to NTP:

news://your_news_server/comp.protocols.time.ntp

Three methods of using the Unison with NTP clients on Unix-like platforms will be described:

Basic: This is the simplest, and will operate without MD5 authentication. **NTP beginners should always perform this setup first.**

MD5: This method is trickier only because MD5 keys must be set up and distributed accurately to the NTP clients in a secure way. The Unison is factory configured to authenticate its replies to NTP MD5 clients using its default set of keys.

Broadcast/Multicast: This method simplifies configuration of the clients on large networks since specific server addresses need not be configured in each client's `/etc/ntp.conf` file. It can be configured either with or without MD5 authentication. However, it is highly recommended that authentication be configured when using broadcast/multicast mode due to the relative ease with which a fake NTP server can take over the clock setting of the broadcast/multicast clients on the network.

Basic NTP Client Setup

Basic setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- You have installed NTP on your client computer.

Configure NTP

You must edit the *ntp.conf* file which **ntpd**, the NTP daemon, looks for by default in the */etc* directory. Add this line to the *ntp.conf* file:

```
server 192.168.1.245
```

This line tells **ntpd** to use the NTP server at address 192.168.1.245 in addition to any other servers which might also be configured in the client's *ntp.conf* file.

Re-start **ntpd** to have it begin using the Unison server. Use the NTP utility **ntpq** to check that **ntpd** is able to communicate with the Unison. After issuing the command

```
ntpq
```

you will see the **ntpq** command prompt:

```
ntpq>
```

Use the command

```
peers
```

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being 'reached'. (You may have to continue issuing the *peers* command for a minute or two before you will see the 'reach' count increment.) If you have other peers configured, verify that the offset information for the Unison server peer and your other peers is in agreement to within a few milliseconds, assuming that the other peers are synchronized to that level of accuracy.

It may also be useful to start the NTP daemon in 'debug' mode (**ntpd -d**) to confirm successful configuration. Refer to the NTP documentation for detailed usage of these debug utilities.

MD5 Authenticated NTP Client Setup

MD5 authenticated setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- Your Unison has been configured to perform authentication either by factory default, or by running the **ntpconfig** shell script. The example Unison authentication configuration shown in *Chapter 2 - Configuring the Network Time Protocol* will be assumed in the example configuration commands shown here.
- You have installed NTP on your client computer.

- You have successfully performed the *Basic NTP Client Setup* on your client computer.

Create the `ntp.keys` File

You must create a file named `ntp.keys` in the `/etc` directory. It must be a copy of the one residing in the `/etc` directory of your Unison. You can `telnet` into your Unison and start an `ftp` session with your client computer to send the Unison's `/etc/ntp.keys` file to your client computer, use the secure copy utility `scp`, or you can just use a text editor on your client computer to create an equivalent file.

IMPORTANT

Handling of the `/etc/ntp.keys` file is the weak link in the MD5 authentication scheme. It is very important that it is owned by `root` and not readable by anyone other than `root`.

After transferring the file by `ftp`, and placing it in the `/etc` directory on the client computer, issue these two commands at the shell prompt:

```
chown root.root /etc/ntp.keys
chmod 600 /etc/ntp.keys
```

Configure NTP

You must edit the `ntp.conf` file which `ntpd`, the NTP daemon, looks for by default in the `/etc` directory. Assuming that you have created two trusted keys as shown in the example in the previous chapter, add these lines to the end of the `ntp.conf` file:

```
keys /etc/ntp.keys
trustedkey 1 2
```

Modify the line added previously in *Basic NTP Client Setup* so that authentication will be used with the Unison server using one of the trusted keys, in this case key # 1:

```
server 192.168.1.245 key 1
```

Re-start `ntpd` to have it begin using the Unison server with MD5 authentication. Use the NTP utility `ntpq` to check that `ntpd` is able to communicate with the Unison. After issuing the command

```
ntpq
```

you will see the `ntpq` command prompt:

```
ntpq>
```

Use the command

```
peers
```

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being 'reached'. (You may have to continue issuing the `peers` command for a minute or two before you will see the 'reach' count increment.)

You can verify that authentication is being used by issuing the command

associations

to display the characteristics of the client server associations. In the “auth” column of the display, you should see “OK” for the row corresponding to the Unison server. If you see “bad”, you should wait a few minutes to be sure that there is a problem since “bad” is the initial state of this setting. If the “bad” indication persists then you must check your configuration for errors. Typically this is due to a typing error in creating the `/etc/ntp.keys` file on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the file by **ftp** or **scp**, this shouldn’t be a problem.) It is also possible to have a typing error in the `/etc/ntp.conf` file that causes the needed key to not be included in the “trustedkey” list.

Broadcast/Multicast NTP Client Setup

Broadcast/multicast client setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- Your Unison has been configured to perform broadcasts or multicasts by running the **ntpconfig** shell script. (This is not the factory default configuration, so be sure to run **ntpconfig**.) If you are going to use MD5 authentication, your Unison must have been configured to operate with authentication in the broadcast/multicast mode, and you must know which of the trusted keys it is using for broadcast/multicast operation. The example Unison configuration shown in *Chapter 2 - Configuring the Network Time Protocol* will be assumed in the example configuration commands shown here.
- You have installed NTP on your client computer.
- You have successfully performed the *MD5 Authenticated NTP Client Setup* on your client computer, if you plan to use MD5 authentication.

Configure NTP

You must edit the `ntp.conf` file which **ntpd**, the NTP daemon, looks for by default in the `/etc` directory. Assuming that your Unison server has been configured to use key 2 for broadcast authentication as shown in the example in chapter 2, make sure that key 2 is included in the **trustedkey** line, and add this line to the end of the `ntp.conf` file:

```
broadcastclient
```

If you are not using MD5 authentication, you would add these lines:

```
disable auth  
broadcastclient
```

If you are using multicast instead of broadcast mode, you would replace the **broadcastclient** keyword with the **multicastclient** keyword. You may remove the line added previously in *Basic NTP Client Setup*:

```
server 192.168.1.245
```

or the authenticated version added in *MD5 Authenticated NTP Client Setup*:

```
server 192.168.1.245 key 1
```


Re-start **ntpd** to have it begin using the Unison as a broadcast or multicast server. Use the NTP utility **ntpq** to check that **ntpd** is able to communicate with the Unison. After issuing the command

ntpq

you will see the **ntpq** command prompt:

ntpq>

Use the command

peers

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being ‘reached’. (You may have to continue issuing the **peers** command for a minute or two before you will see the ‘reach’ count increment.)

If you are using authentication, you can verify that authentication is being used by issuing the command

associations

to display the characteristics of the client server associations. In the “auth” column of the display, you should see “OK” for the row corresponding to the Unison server. If you see “bad”, you should wait a few minutes to be sure that there is a problem since “bad” is the initial state of this setting. If the “bad” indication persists then you must check your configuration for errors. Typically this is due to a typing error in creating the */etc/ntp.keys* file on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the file by **ftp** or **scp**, this shouldn’t be a problem.) It is also possible to have a typing error in the */etc/ntp.conf* file that causes the needed key to not be included in the “trustedkey” list.

ChapterFour

Setting Up NTP Clients on Windows NT 4.0/2000/XP

To configure your Windows NT 4.0/2000/XP computer to use your Unison, you must have successfully completed the Basic Installation procedures in Chapter 2. This manual is not a 'How-To' on installing and using NTP; basic approaches to NTP configuration for operation with the Unison will be described here. Installation must be performed by a user with administrative privileges on the system. If you have never used NTP, then you should spend some time reading the on-line documents at: <http://www.ntp.org>.

Although all the information is available at the above site, the following are excellent tutorials on setting up NTP and are easier to understand:

<http://www.sun.com/solutions/blueprints/0701/NTP.pdf>
<http://www.sun.com/solutions/blueprints/0801/NTPpt2.pdf>
<http://www.sun.com/solutions/blueprints/0901/NTPpt3.pdf>

Many problems may also be solved by the helpful people who participate in the Internet news group devoted to NTP:

news://your_news_server/comp.protocols.time.ntp

Three methods of using the Unison with NTP clients on Window NT 4.0 platforms will be described:

Basic: This is the simplest, and will operate without MD5 authentication. **NTP beginners should always perform this setup first.**

MD5: This method is trickier only because MD5 keys must be set up and distributed accurately to the NTP clients in a secure way. The Unison is factory configured to authenticate its replies to NTP MD5 clients using its default set of keys.

Broadcast/Multicast: This method simplifies configuration of the clients on large networks since specific server addresses need not be configured in each client's `\winnt\system32\drivers\etc\ntp.conf` file. It can be configured either with or without MD5 authentication. However, it is highly recommended that authentication be configured when using broadcast /multicast mode due to the relative ease with which a fake NTP server can take over the clock setting of the broadcast/multicast clients on the network.

Basic NTP Client Setup

Basic setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- You have installed NTP on your client computer.

Configure NTP

You must edit the *ntp.conf* file which **ntpd.exe**, the NTP daemon, looks for by default in the the *\winnt\system32\drivers\etc* directory of the boot partition. If your NTP installation placed this file in a different place, you must find it and edit it. For example, XP uses *\windows\system32\drivers\etc*. Add this line to the *ntp.conf* file:

```
server 192.168.1.245
```

This line tells **ntpd.exe** to use the NTP server at address 192.168.1.245 in addition to any other servers which might also be configured in the *ntp.conf* file.

Re-start **ntpd.exe** to have it begin using the Unison server. By default, the NTP installation program installs **ntpd.exe** as a service called Network Time Protocol, and starts it. You must use the Services utility in Control Panel to stop the Network Time Protocol service and then re-start it.

Use the NTP utility **ntpq.exe** to check that **ntpd.exe** is able to communicate with the Unison. By default it is installed in the *\Program Files\Network Time Protocol* sub-directory of your Windows NT/2000/XP partition. From a console window, after issuing the command

```
ntpq
```

you will see the **ntpq.exe** command prompt:

```
ntpq>
```

Use the command

```
peers
```

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being ‘reached’. (You may have to continue issuing the peers command for a minute or two before you will see the ‘reach’ count increment.) If you have other peers configured, verify that the offset information for the Unison server peer and your other peers is in agreement to within a few milliseconds, assuming that the other peers are synchronized to that level of accuracy.

It may also be useful to start the NTP daemon in ‘debug’ mode (**ntpd -d**) to confirm successful configuration. The debug version of the NTP daemon is located in the *debug* sub-directory of your NTP directory. Refer to the NTP documentation for detailed usage of these debug utilities.

MD5 Authenticated NTP Client Setup

MD5 authenticated setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- Your Unison has been configured to perform authentication either by factory default, or by running the **ntpconfig** shell script. The example Unison authentication configuration shown in *Chapter 2 - Configuring the Network Time Protocol* will be assumed in the example configuration commands shown here.
- You have installed NTP on your client computer.
- You have successfully performed the *Basic NTP Client Setup* on your client computer.

Create the ntp.keys File

You must create a file named *ntp.keys* in the `\winnt\system32\drivers\etc` directory or, for XP, the `\windows\system32\drivers\etc` directory. It must be a copy of the one residing in the `/etc` directory of your Unison. You can **telnet** into your Unison and start an **ftp** session with your client computer to send the Unison `/etc/ntp.keys` file to your client computer, or use the secure copy utility **scp**, or use a text editor to create the equivalent file. Although you should first test your setup using the factory default `/etc/ntp.keys` file in your Unison server, you should create your own keys after you understand the process and have your clients operating correctly with the default file.

IMPORTANT

Handling of the `\windows\system32\drivers\etc\ntp.keys` file is the weak link in the MD5 authentication scheme. It is very important that it is owned by "administrator" and not readable by anyone other than "administrator".

After transferring the file, make sure that its security properties are set such that it is readable only by the "administrator".

Configure NTP

You must edit the *ntp.conf* file which **ntpd.exe**, the NTP daemon, looks for by default in the `\winnt\system32\drivers\etc` directory. If your NTP installation placed this file in a different place, you must find it and edit it. For example, XP uses `\windows\system32\drivers\etc`. Add these lines to the end of the *ntp.conf* file:

```
keys \winnt\system32\drivers\etc\ntp.keys
trustedkey 1 2
```

Modify the line added previously in *Basic NTP Client Setup* so that authentication will be used with the Unison server using one of the trusted keys, in this case key # 1:

```
server 192.168.1.245 key 1
```

Re-start **ntpd.exe** to have it begin using the Unison server with MD5 authentication. By default,

the NTP installation program installs **ntpd.exe** as a service called Network Time Protocol, and starts it. You must use the Services utility in Control Panel to stop the Network Time Protocol service and then re-start it.

Use the NTP utility **ntpq.exe** to check that **ntpd.exe** is able to communicate with the Unison. By default it is installed in the *\Program Files\Network Time Protocol* sub-directory of your Windows NT/2000/XP partition. From a console window, after issuing the command

```
ntpq
```

you will see the **ntpq.exe** command prompt:

```
ntpq>
```

Use the command

```
peers
```

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being ‘reached’. (You may have to continue issuing the peers command for a minute or two before you will see the ‘reach’ count increment.)

You can verify that authentication is being used by issuing the command

```
associations
```

to display the characteristics of the client server associations. In the “auth” column of the display, you should see “OK” for the row corresponding to the Unison server. If you see “bad”, you should wait a few minutes to be sure that there is a problem since “bad” is the initial state of this setting. If the “bad” indication persists then you must check your configuration for errors. Typically this is due to a typing error in creating the *\winnt\system32\drivers\etc\ntp.keys* file on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the file by **ftp** or **scp**, this shouldn’t be a problem.) It is also possible to have a typing error in the *\winnt\system32\drivers\etc\ntp.conf* file that causes the needed key to not be included in the “trustedkey” list.

Broadcast/Multicast NTP Client Setup

Broadcast/multicast client setup is relatively simple, if:

- You have been able to successfully communicate with the Unison on your network.
- Your Unison has been configured to perform broadcasts or multicasts by running the **ntpconfig** shell script. (This is not the factory default configuration, so be sure to run **ntpconfig**.) If you are going to use MD5 authentication, your Unison must have been configured to operate with authentication in the broadcast/multicast mode, and you must know which of the trusted keys it is using for broadcast/multicast operation. The example Unison configuration shown in *Chapter 2 - Configuring the Network Time Protocol* will be assumed in the example configuration commands shown here.
- You have installed NTP on your client computer.
- You have successfully performed the *MD5 Authenticated NTP Client Setup* on your client computer, if you plan to use MD5 authentication.

Configure NTP

You must edit the *ntp.conf* file which **ntpd.exe**, the NTP daemon, looks for by default in the the `\winnt\system32\drivers\etc` directory or, for XP, the `\windows\system32\drivers\etc` directory. Assuming that your Unison server has been configured to use key 2 for broadcast authentication as shown in the example in chapter 2, make sure that key 2 is included in the **trustedkey** line, and add this line to the end of the *ntp.conf* file:

```
broadcastclient
```

If you are not using MD5 authentication, you would add these lines:

```
disable auth  
broadcastclient
```

If you are using multicast instead of broadcast mode, you would replace the **broadcastclient** keyword with the **multicastclient** keyword. You may remove the line added previously in *Basic NTP Client Setup*:

```
server 192.168.1.245
```

or the authenticated version added in *MD5 Authenticated NTP Client Setup*:

```
server 192.168.1.245 key 1
```

Re-start **ntpd.exe** to have it begin using the Unison as a broadcast or multicast server. By default, the NTP installation program installs **ntpd.exe** as a service called Network Time Protocol, and starts it. You must use the Services utility in Control Panel to stop the Network Time Protocol service and then re-start it.

Use the NTP utility **ntpq.exe** to check that **ntpd.exe** is able to communicate with the Unison. By default it is installed in the `\Program Files\Network Time Protocol` sub-directory of your Windows NT/2000/XP partition. After issuing the command

```
ntpq
```

you will see the **ntpq.exe** command prompt:

```
ntpq>
```

Use the command

```
peers
```

to display the NTP peers which your computer is using. One of them should be the Unison server which you have just configured. You should verify that it is being ‘reached’. (You may have to continue issuing the peers command for a minute or two before you will see the ‘reach’ count increment.)

If you are using authentication, you can verify that authentication is being used by issuing the command

```
associations
```

to display the characteristics of the client server associations. In the “auth” column of the display,

you should see “OK” for the row corresponding to the Unison server. If you see “bad”, you should wait a few minutes to be sure that there is a problem since “bad” is the initial state of this setting. If the “bad” indication persists then you must check your configuration for errors. Typically this is due to a typing error in creating the `\windows\system32\drivers\etc\ntp.keys` file on the client that causes a mismatch between the keys being used by the server and client. (If you transfer the file by **ftp** or **scp**, this shouldn’t be a problem.) It is also possible to have a typing error in the `\windows\system32\drivers\etc\ntp.conf` file that causes the needed key to not be included in the “trustedkey” list.

ChapterFive

Control and Status Commands

This chapter describes the Unison control and status commands. In addition to a subset of the standard Linux shell commands/utilities, the Unison supports several application-specific commands for performing initialization/setup and for monitoring the performance and status of the NTP and GPS subsystems. The standard Linux commands are not documented here. A wealth of information is available from a variety of sources on those. Only the Unison specific commands will be described. The serial I/O port physical and electrical characteristics are defined as well.

General Linux Shell Operation

The command shell used by the Unison is the Linux standard: **bash**. All commands and file names are case sensitive, which is standard for Unix-like operating systems. If you are unfamiliar with Unix-like operating systems, and you would like to be able to more closely monitor or optimize the performance of your Unison you should consult either the web

<http://www.linuxdoc.org>

or good Linux reference books like:

Linux in a Nutshell, Seiver, O'Reilly & Associates, 1999.

Running Linux, Welsh, Dalheimer & Kaufman, O'Reilly & Associates, 1999

to learn the ins and out of the Linux command console.

Available User Commands

COMMAND	FUNCTION
accessconfig	Interactive shell script that guides the user in configuring telnet , ssh and snmpd access to the Unison that is limited to specific hosts. The resulting <i>/etc/hosts.allow</i> and <i>/etc/hosts.deny</i> files are saved to the non-volatile FLASH disk. Factory default configuration allows access by all hosts.
eraserootfs_1	Command to erase the UPGRADE root file system FLASH partition. This must be executed prior to loading the new file system image during the Linux/NTP upgrade process.
gntpwaddr	Prints the ethernet hardware address, if the ethernet has been configured.
gntposctype	Prints the installed oscillator type, which is TCXO or MS-OCXO.
gntpasswd	Allows the <i>root</i> user to change the password for the two configured users on the Unison: <i>gntpuser</i> and <i>root</i> . This script calls the standard Linux passwd binary and then saves the resulting <i>/etc/shadow</i> file to the non-volatile FLASH disk.
gntprootfs	Prints the current root file system image, either UnisonGPS_0 (factory default) or UnisonGPS_1 (field upgrade) which is running in the Unison to the console.
gntpstat	Parses the output of ntpq -c peers to obtain the system peer status of the NTP GPS reference clock. It also retrieves the current reference clock polling status data and prints it to the console.
gntptimemode	Prints the time mode settings in effect for any optional time-code output.
gntptimemodeconfig	Interactive shell script that guides the user in configuring the time mode settings for any optional timecode output. Allows setting to the LOCAL, GPS or UTC timescale and if LOCAL, the setting of the offset to UTC and the Daylight Savings Time (DST) start and stop date/time parameters.
gntpversion	Prints the Unison application software version information to the console.
gpsdynmode	Prints the GPS dynamic mode currently in effect to the console.
gpsrefpos	Prints the GPS reference position to the console.
gpsstat	Prints the GPS subsystem status information to the console.
gpstrkstat	Prints the GPS satellite tracking status to the console.
gpsversion	Prints the GPS firmware and FPGA version information to the console.
help	Prints help for Unison commands (not Linux).
inetdconfig	Interactive shell script that allows the user to configure the list of protocol servers which are started by the inetd server daemon running in the Unison.

netconfig	Interactive shell script that allows the user to configure the IP network subsystem of the Unison.
ntpconfig	Interactive shell script that guides the user in configuring the Unison NTP subsystem. Allows configuration of MD5 authentication and broadcast/multicast mode. All parameters are retained in non-volatile FLASH disk storage.
setgpsdynmode	Allows the user to set the dynamic mode of operation of the GPS subsystem. It may be ON or OFF.
setgpsrefpos	Interactive shell script that prompts the user for an accurate reference position, performs syntax and argument validity checking then passes the position to the GPS subsystem.
updaterootflag	Command to update the flag stored in FLASH that is read by the Linux bootloader at boot time to select operation with either the FACTORY or UPGRADE root file system.
upgradegps	Shell script that facilitates the GPS subsystem firmware upgrade process.

Detailed Command Descriptions

accessconfig

This command starts an interactive shell script that will allow the root user to configure limitation of **telnet**, **ssh** and **snmp** access to the Unison. By default, the unit is configured to allow access by all users. If you need to limit **telnet**, **ssh** or **snmp** access, e.g. for security reasons, you must run this script as root from either the RS-232 serial I/O port or from a **telnet** or **ssh** session.

This script modifies these files: */etc/hosts.allow* and */etc/hosts.deny*. These are non-volatily stored in the FLASH disk */boot/etc* directory. You must re-boot the Unison after running this script for the changes to take effect.

Set: **accessconfig**
Unison response: Interactive shell script is started.

eraserootfs_1

This command erases the UPGRADE root file system FLASH partition in preparation for performing a Linux/NTP subsystem firmware upgrade. See *Appendix B - Upgrading the Firmware* for more information.

Set: **eraserootfs_1**
Unison response: Erase progress as percent is shown.

gntphwaddr

This command displays the ethernet hardware address, if the IP network is properly configured. Otherwise it returns nothing.

Query: **gntphwaddr**
Unison response: **00:D0:C9:25:78:59**

gntposctype

This command displays the installed oscillator type. It is TCXO or MS-OCXO. The standard oscillator is the TCXO.

Query: **gntposctype**
 Unison response: **Installed Oscillator is TCXO.**

gntpasswd

This command allows the root user to change the passwords of the two configured users on the system: *root* and *gntpuser*. Arguments passed to **gntpasswd** on the command line are passed verbatim to the real **passwd** binary program. When **passwd** returns, the resulting modified */etc/shadow* file is copied to the non-volatile */boot/etc* directory.

Query: **gntpasswd gntpuser**
 Unison response: **Passwd interactive utility is started.**

gntprootfs

This command displays the currently booted root file system image. It can be either UnisonGPS_0 (factory image) or UnisonGPS_1 (field upgrade image). Refer to *Appendix B - Upgrading the Firmware* for detailed instructions on performing the upgrade procedure.

Query: **gntprootfs**
 Unison response: **BOOT_IMAGE=UnisonGPS_1**

gntpstat

This command allows the user to query the status of the NTP subsystem. It retrieves information from the NTP distribution **ntp** binary using the **peers** command to determine the current synchronization status of the NTP subsystem. It then retrieves the last line in the logfile */var/log/praecis0.monitor* controlled by the NTP daemon reference clock driver that communicates with the GPS timing subsystem. This logfile is updated every 16 seconds under normal operation. It parses and formats the data contained therein and prints this fixed-length (generally, grossly unsynchronized states could cause the floating offset field to overflow momentarily) string having these fields:

```
LKSTAT TO GPS, Offset = +S.ssssss, TFOM = ? @ YEAR DOY HH:MM:SS.sssssssss LS
```

Where:

LKSTAT is the system peer status of the NTP daemon relative to the GPS subsystem engine, either **LOCKED** or **NOTLKD**. **NOTLKD** can imply several things: the system has just started, there is a fault in the GPS subsystem which has caused NTP to either be unable to obtain timing information from the GPS subsystem or to reject the timing information that it is obtaining from it.

+S.ssssss is the offset in seconds between the NTP system clock and the GPS subsystem clock. Positive implies that the system clock is ahead of the GPS subsystem clock.

TFOM = ? A detailed explanation of TFOM is in *Appendix E - Time Figure-of-Merit*.

Briefly, TFOM indicates clock accuracy where:

- 4 time error is < 1 us
- 5 time error is < 10 us

- 6 time error is < 100 us
- 7 time error is < 1 ms
- 8 time error is < 10 ms
- 9 time error is > 10 ms, unsynchronized state if never locked to GPS.

YEAR is the year of the UTC timestamp of most recent NTP polling request received by the GPS engine from the NTP reference clock driver.

DOY is the day-of-year of the UTC timestamp of most recent NTP polling request received by the GPS engine from the NTP reference clock driver.

HH:MM:SS.ssssssss is the hour, minute, second.subsecond UTC timestamp of the most recent NTP polling request received by the GPS engine from the NTP daemon reference clock driver.

LS is the current number of leap seconds difference between the UTC and GPS timescales (13 at the time of this writing).

Query: **gntpstat**

Unison response:

LOCKED TO GPS, Offset = +0.000024, TFOM = 4 @ 2001 092 06:03:10.904312858 13

gntptimemode

This command displays the current time mode settings for any optional timecode outputs. The displayed Local Time Offset from UTC and the DST Start/Stop parameters are only valid when the Time Mode is LOCAL. A positive Local Time Offset implies a longitude east of the Greenwich meridian and that local time is ahead of UTC.

Query: **gntptimemode**

Unison response:

**Time Mode = LOCAL
Local Time Offset from UTC = -16 (half hours)
DST Start Month = Apr Sunday = 1st Hour = 02
DST Stop Month = Oct Sunday = Last Hour = 02**

gntptimemodeconfig

This command starts an interactive shell script that will allow the user to configure the time mode of operation of any optional timecode outputs. *These settings have no effect on the operation of the NTP daemon or the underlying Linux operating system time. These ALWAYS operate in UTC.*

By default, the unit is configured to operate in LOCAL mode with an offset to UTC of zero and with Daylight Savings Time disabled. If you need to modify this operation, you must run this script as root. Settings made using this command are non-volatile.

Set: **gntptimemodeconfig**

Unison response: Interactive shell script is started.

gntpversion

This command displays the firmware version and build date of the Unison.

Query: **gntpversion**
 Unison response:
Unison GPS 6010-0042-000 v 1.00 Wed Jan 16 22:38:21 UTC 2004

gpsdynmode

This command displays the current GPS subsystem dynamic mode of operation. It has two possible settings: ON or OFF. When it is ON, it is assumed that the Unison is installed on a moving platform. When it is OFF, it is assumed that the Unison is installed in a stationary location.

When the dynamic mode is OFF, the Unison will use its accurate reference position to implement Timing Receiver Autonomous Integrity Monitoring (TRAIM) for the utmost in reliability during any GPS system faults. In addition, single satellite operation is possible once an initial accurate position has been determined.

When the dynamic mode is ON, only a very minimal TRAIM algorithm is in effect because the accurate reference position is not static. In addition, a minimum of four satellites must be visible and only 3-D position fixes are used. When the dynamic mode is ON, the source reported for the accurate reference position by **gpsrefpos** is set to DYN.

Query: **gpsdynmode**
 Unison response: **OFF**

gpsrefpos

This command displays the current GPS subsystem reference position. The source of the position, which is one of UNK (unknown), DYN (dynamic), USR (user entered) or AVG (24 hour average of GPS fixes) is displayed first. The WGS-84 latitude and longitude in degrees, minutes, seconds format and the height above the WGS-84 reference ellipsoid in meters follow. Refer to *Appendix D - GPS Reference Position* for details.

Query: **gpsrefpos**
 Unison response:
CURRENT REFERENCE POSITION = AVG N38d26m36.11s W122d42m56.50s +00032.5 meters

gpsstat

This command allows the user to query the status of the GPS timing subsystem. During normal operation, the NTP daemon polls the GPS timing subsystem every 16 seconds. The results of this poll are used to steer the system clock and are saved to a log file. This command parses and formats the data contained therein and prints this fixed-length string having these fields:

LKSTAT TFOM = ? YEAR DOY HH:MM:SS.ssssssssss LS LF S N VCDAC SN.R FLTS

Where:

LKSTAT is the tracking status of the engine, either LOCKED or NOTLKD.

TFOM = ? A detailed explanation of TFOM is in *Appendix E - Time Figure-of-Merit*.

Briefly, TFOM indicates clock accuracy where:

- 4 time error is < 1 us
- 5 time error is < 10 us
- 6 time error is < 100 us

- 7 time error is < 1 ms
8 time error is < 10 ms
9 time error is > 10 ms, unsynchronized state if never locked to GPS.
- YEAR is the year of the UTC timestamp of the most recent NTP polling request received by the GPS engine from the NTP reference clock driver.
- DOY is the day-of-year of the UTC timestamp of most recent NTP polling request received by the GPS engine from the NTP reference clock driver.
- HH:MM:SS.ssssssss is the hour, minute, second.subsecond UTC timestamp of the most recent NTP polling request received by the GPS engine from the NTP daemon reference clock driver.
- LS is the current number of leap seconds difference between the UTC and GPS timescales (13 at the time of this writing).
- LF is the future (at the next UTC midnight) number of leap seconds difference between the UTC and GPS timescales (13 at the time of this writing).
- S is the Signal Processor State, one of 0 (Acquiring), 1 (GPS Locking), 2 (GPS Locked).
- N is the number of GPS satellites being tracked, 0 to 8.
- VCDAC is the upper 16 bits of the oscillator Voltage Control DAC word, 0 to 65535 with larger numbers implying higher oscillator frequency. Typical range is 20000 to 38000.
- SN.R is the carrier Signal to Noise Ratio, 0.00 to 99.9, measured in dB in the GPS data rate bandwidth. Typical range is 30 to 45.
- FLTS is the fault status, which displays the current summary status of the GPS timing subsystem. The summary status is contained in sixteen bits which are displayed in four hexadecimal characters. Assertion of any of these bits will also be indicated by illumination of the red LED. Each bit of each character indicates the status of a subsystem component:

	Bit 3	Bit 2	Bit 1	Bit 0
Char 0	FLASH Write Fault	FPGA Config Fault	No Signal Time-Out	DAC Control Over-Range
Char 1	Antenna Fault	No Polling Events	Time Input Fault	GPS Comm Fault
Char 2	Not Used	Not Used	Not Used	Not Used
Char 3	Not Used	Not Used	Not Used	Not Used

DAC Control Over-Range: This bit indicates that the electronic frequency control DAC for the oscillator has reached either the high (55000) or low (10000) limit while locked to the GPS signal. Unless the unit is being subjected to out-of-specification environmental conditions, this would indicate that the oscillator frequency has drifted near to the end of life region. This should normally only occur after about ten years of operation. The unit will continue to function until the oscillator

frequency finally reaches one of the actual DAC endpoints. The unit should be returned to the factory for oscillator replacement at the customer's convenience.

No Signal Time-Out: This bit indicates that the unit has not been able to acquire a GPS signal for one hour while the Time Figure of Merit has been 9, the unsynchronized condition. This could be due to a variety of reasons. If there are no other faults that could explain the inability to receive a signal, then there could be an or antenna failure or blockage. If the condition persists indefinitely, and a problem with the antenna is not evident, the unit may need to be returned to the factory for repair.

FPGA Config Fault: This bit indicates that the microprocessor was unable to configure the FPGA. This would be a fatal fault and the unit should be returned to the factory for repair .

FLASH Write Fault: This bit indicates that the microprocessor was unable to verify a write to the FLASH non-volatile parameter storage area. This should not ever occur under normal operation. This fault would cause erratic operation at the next power cycling since important parameters could be corrupt. The unit should be returned to the factory for repair.

GPS Comm Fault: This bit indicates that the microprocessor is unable to establish communications with the GPS engine. Please report this fault condition to the factory (1-877-749-3878).

Time Input Fault: This bit indicates that the microprocessor received an erroneous time input from the GPS engine. If the condition persists please report it to the factory (1-877-749-3878).

No Polling Events: This bit indicates that the GPS timing subsystem is not receiving polling request from the NTP subsystem. This could be due to a hardware or software failure. If the condition persists after cycling the power to the unit, this is a fatal fault and the unit should be returned to the factory for repair.

Antenna Fault: This bit indicates that the GPS antenna or download cable has a fault. It indicates either an over or under current condition. Usually it means that the antenna download cable is not plugged into the connector on the rear of the Unison. If the condition persists after checking the antenna/download for obvious faults, this is a fatal fault and the unit should be returned to the factory for repair.

The example response indicates that there has been a period without tracking a GPS signal that exceeded the time-out period, that there was a FLASH Write Fault and that there is an Antenna Fault.

Query: **gpsstat**

Unison response:

LOCKED TFOM = 4 2001 092 04:48:56.347916732 13 13 2 7 28605 41.6 008A

gpstrkstat

This command displays the current GPS subsystem satellite tracking status. A list of eight satellite numbers is displayed, one for each receiver channel. Satellite number 0 is an invalid number and indicates that no satellite is being tracked on that channel. Valid satellite numbers range from 1 to 32.

Query: **gpstrkstat**

Unison response:

CURRENT SVs TRKD = 08 11 13 22 31 00 00 00

gpsversion

This command displays the firmware and hardware versions of the GPS subsystem.

Query:	gpsversion
Unison response:	F/W 1.00 FPGA 0202

help

This command displays a list of the Unison commands (not Linux commands). To get help on a particular command you would type **help**, followed by the command.

Query:	help
Unison response:	Tempux LX commands are displayed.

Query:	help gpsstat
Unison response:	Information specific to the gpsstat command is displayed.

inetdconfig

This command starts an interactive shell script that will allow the user to configure the list of protocol servers which are started by the **inetd** server daemon running in the Unison. Four protocol servers may be configured: TIME, DAYTIME, TELNET and SSH. By default, the unit is configured to start all of these protocol servers. If you need to disable start-up of some or all of these, e.g. for security reasons, you must run this script as *root* from either the RS-232 serial I/O port or from a **telnet** or **ssh** session.

This script modifies the */etc/inetd.conf* file, which is non-volatilely stored in the FLASH disk */boot/etc* directory. You must re-boot the Unison after running this script for the changes to take effect.

Set:	inetdconfig
Unison response:	Interactive shell script is started.

netconfig

This command starts an interactive shell script that will allow the user to configure the IP network subsystem of the Unison. By default, the unit is configured to configure itself using the Dynamic Host Configuration Protocol (DHCP). If you need to set up static IP configuration, you must run this script as *root* from the RS-232 serial I/O port during the installation process. Refer to **Chapter 2 - Using netconfig to Set Up Your IP** for details on the use of the command.

This script creates or modifies these files: */etc/HOSTNAME*, */etc/hosts*, */etc/networks*, */etc/resolv.conf* and */etc/rc.d/rc.inet1*. All of these are non-volatilely stored in the FLASH disk */boot/etc* directory. You must re-boot the Unison after running this script for the changes to take effect.

Set:	netconfig
Unison response:	Interactive shell script is started.

ntpconfig

This command starts an interactive shell script that will allow the user to configure the NTP subsystem of the Unison. By default, the unit is configured to authenticate its replies to clients using its default MD5 keys in the */etc/ntp.keys* file. If you need to create your own MD5 keys (recommended) or set up broadcast/multicast operation, you must run this script as *root*. Refer to **Chapter 2 - Configuring the Network Time Protocol** for details on the use of this command.

The two files that are modified are `/etc/ntp.keys` and `/etc/ntp.conf`. Both of these are non-volatily stored in the FLASH disk `/boot/etc` directory. You must re-boot the Unison after running this script for the changes to take effect.

```
Set:                               ntpconfig
Unison response:                   Interactive shell script is started.
```

setgpsdynmode

This command accepts a single argument: ON or OFF to allow the user to set the dynamic mode of operation of the GPS subsystem. By default, the unit is configured for static operation, so this setting is OFF. If the Unison will be mounted on a moving platform, like a ship, then this setting must be changed to ON. The change takes place immediately and is stored non-volatily.

```
Set:                               setgpsdynmode ON
Unison response:                   GPS Dynamic Mode is ON.
```

setgpsrefpos

This command starts an interactive shell script that will allow the user to set the accurate, reference position of the Unison. By default, the unit is configured to locate itself using the GPS satellites. In some situations, visibility of the sky is limited and the unit will not be able to determine its position. In this case, the user must determine an accurate WGS-84 position by other means and input it using this command. If you need to set the accurate reference position, you must run this script as root. The changes take place immediately. Refer to *Appendix D - GPS Reference Position* for details. *If the GPS dynamic mode setting is ON (see `gpsdynmode/setgpsdynmode` commands), then running this script will have no effect.*

In addition to setting a new accurate, reference position, the user can also invalidate an existing one. This will force the Unison to re-establish a new reference position using the GPS satellite constellation.

```
Set:                               setgpsrefpos
Unison response:                   Interactive shell script is started.
```

updaterootflag

This command allows the user to update the configuration of the Linux bootloader after a new root file system image has been uploaded to the UPGRADE root file system partition, `/dev/rootfs_1` of the Unison FLASH disk. It may also be used to reset the default back to the FACTORY root file system partition. Refer to *Appendix B - Upgrading the Firmware* for detailed instructions for performing the upgrade procedure. One argument is accepted, whose value is either 0 or 1, causing a flag to be set that will indicate to the bootloader which root file system image should be loaded by default. If an argument value of 2 is given, then the currently configured default root file system is shown.

```
Set:                               updaterootflag 1
Unison response:                   UPGRADE is the default root file system.

Query:                             updaterootflag 2
Unison response:                   UPGRADE is the default root file system.
```

upgradegps

This script allows the user to upgrade the GPS subsystem firmware. It requires one argument: the

path to the binary file to be uploaded to the GPS engine. It issues the commands over the serial port to the GPS subsystem that are needed to start the X-modem file transfer, and then displays the responses from the GPS subsystem to the console. When the X-modem 'C' character appears, indicating that the GPS subsystem is ready to receive the file, you must hit the <ENTER> key, and the transfer will begin. After about one minute, it should complete, at which point you should see the GPS subsystem boot messages appear on the console. From these, you will be able to verify that the firmware was successfully upgraded.

In the example console output below, lines which begin with "---" are generated by the **upgradegps** script. All other lines are from the GPS subsystem, with the exception of the shell message indicating that the process **cat < /dev/arm_user** has been terminated, which is normal. In this example, the 'C' character was received three times before the user hit the <ENTER> key to begin the transfer. The last three lines are the boot messages that are sent by the GPS subsystem as it comes up. The firmware version should match that of the binary file that was uploaded. See *Performing the GPS Upgrade* in *Appendix B - Upgrading the Firmware* for more information.

```
Set:                                upgradegps /tmp/6010-0020-000.bin
Unison response:
---When you see the `C` character, hit <enter> to begin the upload.

Waiting for download using XMODEM 128 or XMODEM 1K (both with CRC).
Control X will abort download.
CCC
---Starting file upload, should take about 60 seconds...

/sbin/upgradegps: line 26: 27618 Terminated          cat </dev/arm_user

---You should see the GPS subsystem startup message now. If not, you
---may need to check your binary file and re-perform the procedure.

Tempus Bootloader 6010-0050-000 v 1.00 - May 28 2004 17:31:05
FW 6010-0020-000 v 1.00 - Aug 18 2004 10:47:41
FPGA 6020-0005-000 v 0202
```

RS-232 Serial I/O Port Signal Definitions

The RS-232 DB9M connector on the rear panel of the Unison is wired as shown below. In order to connect the Unison to another computer, a null-modem adapter must be used. The serial cable provided with the shipment is wired as a null-modem adapter and can be used to connect the Unison to your computer.

Unison DB9M Pin	Signal Name
1	Not Connected
2	Receive Data (RX)
3	Transmit Data (TX)
4	Data Terminal Ready (DTR)
5	Ground
6	Data Set Ready (DSR)
7	Request To Send (RTS)
8	Clear To Send (RTS)
9	Not Connected

Appendix A

Security

Your Unison incorporates several important security features to prevent unauthorized tampering with its operation. Many of these are standard multiple-user access control features of the underlying Linux operating system which controls the Unison. Others are provided by the additional protocol servers selected for inclusion in your Unison, and the way that they are configured.

*Secure user authentication and session privacy while performing routine monitoring and maintenance tasks are provided by the OpenSSH implementations of the “secure shell” daemon, **sshd** and its companion “secure copy” utility, **scp**. The UCD-SNMP implementation of the Simple Network Management Protocol (SNMP) daemon, **snmpd**, conforms to the latest Internet standard, known as SNMPv3, which also supports secure user authentication and session privacy. In addition, the Network Time Protocol daemon, **ntpd** supports client-server authentication security measures to deter spoofing of NTP clients by rogue NTP servers. This appendix describes these security measures and gives the advanced network administrator information that will allow custom configuration to fit specific security needs.*

Linux Operating System

The embedded Linux operating system running in the Unison is based on kernel version 2.4.26 and version 7 of the Slackware Linux distribution. As such it supports a complete set of security provisions:

- System passwords are kept in an encrypted file, `/etc/shadow` which is not accessible by users other than `root`.
- Direct `root` logins are only permitted on the local RS-232 console or via SSH.
- The secure copy utility, **scp**, eliminates the need to use the insecure **ftp** protocol for transferring program updates to the Unison.
- Access via SNMP is configurable to provide the security of the latest version 3 Internet standard which supports both view-based access control and user-based security using modern encryption techniques. Previous versions v1 and v2c supported access control essentially via passwords transmitted over the network in plain text. Refer to *Appendix C – Simple Network Management Protocol* which is dedicated to configuration of SNMP for details.
- Individual host access to protocol server daemons such as **in.telnetd**, **snmpd** or **sshd** may be controlled by the **tcpd** daemon and `/etc/hosts.allow` and `/etc/hosts.deny`.
- Risky protocols like TIME, DAYTIME and TELNET may be completely disabled by configuration of the **inetd** super-server daemon.

The last two topics are supported on the Unison by a pair of shell scripts which ease configuration for the inexperienced user of Unix-like operating systems. These are **accessconfig** and **inetdconfig**.

accessconfig modifies two files which are used by **tcpd** and the standalone daemon, **snmpd** to determine whether or not to grant access to a requesting host: */etc/hosts.allow* and */etc/hosts.deny*. These two files may contain configuration information for a number of protocol servers, but in the Unison only access control to the protocol server daemons **in.telnetd**, **sshd** and **snmpd** is configured.

As shipped from the factory, these two files are empty. When the user runs **accessconfig**, these lines are added to the */etc/hosts.deny* file:

```
in.telnetd: ALL
sshd: ALL
snmpd: ALL
```

This tells **tcpd** to deny access to **in.telnetd** and **sshd** to all hosts not listed in the */etc/hosts.allow* file. The **snmpd** daemon also parses this file itself prior to granting access to a requesting host. Then the user is prompted to enter a list of hosts that will be granted access to **in.telnetd**, **sshd** and **snmpd**. These appear in the */etc/hosts.allow* as lines like this:

```
in.telnetd: 192.168.1.2, 192.168.1.3
sshd: 192.168.1.2, 192.168.1.3
snmpd: 192.168.1.2, 192.168.1.3
```

This simple shell script handles the needs of most users, however the syntax of these two files supports elaborate configuration possibilities which are beyond the capabilities of this simple shell script. Advanced users who need these capabilities will need to edit these two files directly and then copy them to the */boot/etc* directory. (A very compact editor with WordStar command keystrokes is available on the system for this purpose: **edit**. If you start **edit** without giving it a file name to open, it will display its help screen, showing the supported keystrokes.) Be careful to maintain the proper ownership and access permissions by using **cp -p** when copying the files.

inetdconfig modifies the */etc/inetd.conf* file which is read by **inetd** to start-up various protocol server daemons when requests from remote hosts are received. Currently, four servers are configurable via **inetdconfig**: **TIME** and **DAYTIME**, whose daemons are contained within the **inetd** daemon itself, and **in.telnetd** and **sshd**. Any one or all of these may be enabled or disabled for start-up.

OpenSSH

The secure shell protocol server running in the Unison is based on the portable OpenSSH for Linux. As such it supports both SSH1 and SSH2 protocol versions. For more information about this protocol and to obtain client software, refer to the OpenSSH website: <http://www.openssh.com>.

An excellent book which describes operation and configuration of the various SSH implementations, including OpenSSH is available from O'Reilly & Associates:

SSH, The Secure Shell, Barrett & Silverman, O'Reilly & Associates, 2001

In the interest of conserving scarce system memory resources, only the secure shell server daemon, **sshd** and the secure copy utility, **scp**, are implemented in the Unison. This means that users on remote hosts may log in to the Unison via an **ssh** client, but users logged in on the Unison are unable to log in to a remote host via **ssh**. Since **scp** runs in concert with an **ssh** client, the same limitations exist for its use, i.e. users on remote hosts may transfer files to and from the Unison via **scp** over **ssh** but users logged in on the Unison are unable to transfer files to and from a remote host via **scp** over **ssh**.

The factory configuration contains a complete set of security keys for both SSH1 and SSH2 versions of the protocol. RSA keys are supported by both versions, and DSA keys are supported when using the SSH2 version.

In addition, the Unison is factory configured with a set of public keys for passwordless, public key authentication of the root user. To use this capability, the corresponding set of private keys for each of the two SSH versions are provided in the */boot/root* directory of the Unison. Three files contain these keys: *identity* (SSH1), *id_rsa* (SSH2) and *id_dsa* (SSH2). These must be copied to the user's *~/.ssh* directory on their remote computer. (Be careful to maintain the proper ownership and access permissions by using **cp -p** when copying the files. They MUST be readable only by *root*.) The corresponding public keys are by factory default resident in the */root/.ssh* directory of the Unison. Two files contain these keys: *authorized_keys* (SSH1) and *authorized_keys2* (SSH2).

Since the provided private keys are not passphrase protected, the user should create a new set of keys after verifying operation with the factory default key sets. After creating the new keys, the public keys should be copied to the */boot/root/.ssh* directory of the Unison. At boot time, the Unison will copy these to the actual */root/.ssh* directory of the system ramdisk, thereby replacing the factory default set of public keys.

Advanced users wishing to modify the configuration of the **sshd** daemon should edit the */etc/sshd_config* file and then copy it to the */boot/etc* directory of the Unison. Be careful to maintain the proper ownership and access permissions by using **cp -p** when copying the file. At boot time, it will be copied to the */etc* directory of the system ramdisk, thereby replacing the factory default configuration file.

Network Time Protocol

The NTP implementation in the Unison is built from the standard distribution from the <http://www.ntp.org> site. By factory default, remote control of the NTP daemon **ntpd** is disabled. Query-only operation is supported from the two NTP companion utilities **ntpq** and **ntpdcc**.

Control via these two utilities is disabled in the */etc/ntp.conf* file in two ways. First, MD5 authentication keys are not defined for control operation via a *requestkey* or *controlkey* declaration. Second, this default address restriction line is present in the file:

```
restrict default notrust nomodify
```

This line eliminates control access from ALL hosts. Query access is not affected by this restriction. Knowledgeable NTP users who would like to customize the security aspects of the configuration of the NTP daemon in the Unison should edit the */etc/ntp.conf* file directly and then copy it to the */boot/etc* directory. Be sure to retain the ownership and permissions of the original file by using **cp -p** when performing the copy.

CAUTION

If you are planning to make changes to the */etc/ntp.conf* file, you must not restrict query access from the local host to the NTP daemon. Various system monitoring processes running on the system require this access.

Appendix B

Upgrading the Firmware

Periodically, EndRun Technologies will make bug fixes and enhancements to our products available for download from our website. All such downloads are freely available to our customers, without charge. After you have downloaded the appropriate FLASH binary image file from the EndRun Technologies website, you are ready to perform the upgrade to your Unison.

The firmware consists of two FLASH binary image files. One of these is the firmware for the Unison itself. This firmware executes on the IBM-compatible CPU and contains the embedded Linux operating system and NTP specific application software. The other file is the firmware for the GPS time and frequency subsystem. Each of these files may be upgraded independently, although some upgrades require both images to be modified together.

What You Need To Perform the Upgrade

You will need to use **ftp** or **scp** to transfer the binary image file(s) to the Unison. This means that you must place the previously downloaded file(s) in a place on your network which is accessible to the Unison.

Performing the Linux/NTP Upgrade

There are two FLASH disk partitions which hold the compressed Linux root file system images. These partitions are raw FLASH blocks, have no file system and may not be mounted. They are accessed through low-level devices. To protect the factory root file system from accidental erasure or over-writing, the device node has been deleted. The upgrade FLASH disk partition is accessed via `/dev/rootfs_1`. When performing an upgrade, you will be copying the new image to this device.

CAUTION

Some browsers will automatically unzip the gzip file when downloading from the website. Please make sure that the gzip file is less than 5M in size before proceeding. Upgrading the partition with a too-large file size can cause serious problems and the unit may have to be returned to the factory for re-programming.

To perform the upgrade, log in as the *root* user to the Unison using the local console serial I/O port, **telnet** or **ssh** and perform these operations:

First erase the upgrade partition by issuing this command at the shell prompt:

```
eraserootfs_1
```

If you are using **ftp** to perform the upgrade, transfer the previously downloaded file using *binary* transfer mode from the remote host to */dev/rootfs_1* on your Unison using FTP (substitute the name of the root file system image that you are installing for *rootfsupgrade.gz*): Issue these commands from the console of your Unison:

```
ftp remote_host           {perform ftp login on remote host}
bin                       {set transfer mode to binary}
get rootfsupgrade.gz /dev/rootfs_1 {transfer the file}
quit                      {close the ftp session after transfer }
```

If you are using **ssh**, you may open a command window on the remote computer and securely transfer the root file system image using **scp** from the remote computer to your Unison. A command like this should be used:

```
scp -p rootfsupgrade.gz root@cntp.your.domain:/dev/rootfs_1
```

Update the default file system partition by issuing this command on your Unison.

```
updaterootflag 1
```

You should see this line displayed:

```
UPGRADE is the default root file system.
```

Now reboot the system by issuing this command at the shell prompt:

```
shutdown -r now
```

Wait about 30 seconds for the system to shutdown and re-boot. Then log in to the Unison using **telnet** or **ssh**. If all has gone well, you should be able to log in the usual way. After you have entered your password, the system message will be displayed. You should notice that it now indicates the software version and date of the upgrade that you previously downloaded. You can also check this at any time by issuing

```
gntpversion
```

which will cause the system message to be re-displayed.

You can also check to see which root file system image the system is currently booted under by issuing this command at the shell prompt:

```
gntprootfs
```

Which should cause this to be printed to the console:

```
BOOT_IMAGE=UnisonGPS_1
```

If so, and your unit seems to be operating normally, you have successfully completed the upgrade. If your unit does not boot up successfully, and you are not able to **telnet** or **ssh** into the system after 30 seconds, then there has been some kind of problem with the upgrade. It is possible that the file downloaded was corrupt or that you forgot to set your FTP download file mode to binary when downloading the file--either from the EndRun Technologies website or when transferring it to the Unison.

Recovering from a Failed Upgrade

To restore your Unison to a bootable state using the factory root file system, you must use the serial I/O port and re-boot the Unison by cycling the power. Refer to *Chapter 2 – Connect the Serial I/O Port and Test the Serial I/O Port* for setup details. When you have connected your terminal to the serial I/O port, apply power to the Unison.

Pay close attention to the terminal window while the unit is re-booting. After the Linux bootloader displays the message

```
To override and boot the FACTORY partition type 'FACTORY' within 5 seconds...
```

you must begin typing “factory” within five seconds to let the bootloader know that you are going to override the default root file system. After you hit <enter> the bootloader will boot the factory root file system. Watch the rest of the boot process to make sure that you have successfully recovered. If the system boots normally, then you should resolve the problems with the previous upgrade and re-perform it.

Performing the GPS Upgrade

To perform this upgrade, log in as the *root* user to the Unison using either the local console serial I/O port, **telnet** or **ssh** and perform these operations:

Change the working directory to the */tmp* directory:

```
cd /tmp
```

If you are using **ftp** to perform the upgrade, transfer the previously downloaded file using *binary* transfer mode from the remote host to the working directory, */tmp* (substitute the name of the GPS subsystem image that you are installing for *gpsupgrade.bin*):

```
ftp remote_host      {perform ftp login on remote host}
bin                  {set transfer mode to binary}
get gpsupgrade.bin    {transfer the file}
quit                 {close the ftp session after the transfer }
```

If you are using **ssh**, you may open another command window on the remote computer and securely transfer the GPS subsystem image to the */tmp* directory using **scp** from the remote computer. A command like this could be used:

```
scp -p gpsupgrade.bin root@gntp.your.domain:/tmp
```

Now issue the following command to the Unison console to initiate the upload:

```
upgradegps /tmp/gpsupgrade.bin
```

This command is a script that performs the file transfer to the GPS engine. It first tells the GPS engine to enter the ‘waiting for download’ mode, and then prompts you with this line

```
---When you see the `C` character, hit <enter> to begin the upload.
```

Then it echos the serial port characters sent by the GPS engine to the console. You should next see this message from the GPS engine:

```
Waiting for download using XMODEM 128 or XMODEM 1K (both with CRC).
Control X will abort download.
```

After about 3 seconds, you should see a capital 'C' character appear. When you do, hit the <enter> key. Now the script will initiate the XMODEM file transfer and display this message to the console:

```
---Starting file upload, should take about 60 seconds...
```

After about one minute you should see this message from the script:

```
/sbin/upgradegps: line 26: 27618 Terminated      cat </dev/arm_user

---You should see the GPS sub-system startup message now.  If not, you
---may need to check your binary file and re-perform the procedure.
```

The first message should be ignored. It is only reporting that one of the intermediate processes of the script execution has been terminated. The next message informs you that the GPS engine file transfer has completed, and that its start-up messages should appear. First the bootloader message will appear:

```
Tempus Bootloader 6010-0050-000 v 1.00 - May 28 2004 17:31:05
```

In about ten seconds, the GPS engine application start-up messages should appear:

```
FW 6010-0020-000 v 1.00 - Aug 18 2004 10:47:41
FPGA 6020-0005-000 v 0202
```

The firmware version should match that of the binary file that you uploaded. At this point, the **upgradegps** script terminates its execution, and you will again have the standard Unison console prompt.

After about one minute, you should query the GPS firmware version using the command:

```
gpsversion
```

The upgraded version information should be displayed.

Problems with the GPS Upgrade

Should you have difficulties with the upgrade due to a corrupt file, power failure during upload, or other accident, do not be alarmed. Even though you may have lost the existing application program, the GPS engine bootloader program will remain intact. On boot up, it will check to see if a valid application program is in the FLASH memory. If there is not, it will immediately go into the 'waiting for download' mode. You may verify this by issuing this command:

```
cat < /dev/arm_user
```

You should now see the 'C' character being received every three seconds. This is the character that the GPS engine bootloader sends to indicate to the XMODEM utility that it is waiting for a download. You may now re-try the upload procedure, assuming that you have corrected any original problem

with the binary file. First kill the **cat** command by typing CTRL-C. You should see a command prompt. Now issue this command to re-transfer the binary file:

```
upgradegps /tmp/gpsupgrade.bin
```


Appendix C

Simple Network Management Protocol (SNMP)

*Your Unison includes the University of California at Davis (UCD)-SNMP version 4.2.5 implementation of a SNMP agent, **snmpd**, and a SNMP notification/trap generation utility, **snmptrap**. It supports all versions of the protocol in use today: SNMPv1 (the original Internet standard), SNMPv2c (never reached standard status, often called “community SNMP”) and SNMPv3 (the latest Internet standard).*

The UCD-SNMP project has its roots in the Carnegie-Mellon University SNMP implementation. For more detailed information about the UCD-SNMP project and to obtain management software and detailed configuration information, you can visit this website: <http://www.net-snmp.org>.

An excellent book which describes operation and configuration of various SNMP managers and agents, including the UCD-SNMP implementations, is available from O'Reilly & Associates:

Essential SNMP, Mauro & Schmidt, O'Reilly & Associates, 2001

If you are planning to operate with SNMPv3, it is highly recommended that you make use of both of these resources to familiarize yourself with the agent configuration concepts.

SNMPv3 Security

Prior to SNMPv3, SNMP had definite security inadequacies due to using two community names in a manner analogous to passwords that were transmitted over the network as clear text. In addition, since no mechanism existed for authenticating or encrypting session data, any number of man-in-the-middle data corruption/replacement exploits were possible in addition to plain old snooping to learn the community names. SNMPv3 implements the User-based Security Model (USM) defined in RFC-2274 which employs modern cryptographic technologies to both authenticate multiple users and to encrypt their session data for privacy, much in the same way that SSH does for remote login shell users.

In addition, it implements the View-based Access Control Model (VACM) defined in RFC-2275. This RFC defines mechanisms for limiting the access of multiple users having various security levels (no authentication, authentication or authentication plus privacy) to specific “views” of the Structure of Management Information (SMI) object tree.

Enterprise Management Information Base (MIB)

In addition to providing the SNMP variables contained in MIB-II as described in RFC-1213, EndRun Technologies has implemented an enterprise MIB using the syntax of the SMI version 2 (SMIv2) as described in RFC-2578:

TEMPUSLXUNISON-MIB

Which is located on your Unison in this ASCII file:

/usr/local/share/snmp/mibs/TEMPUSLXUNISON-MIB.txt

In addition to a complete set of NTP and GPS status objects, the MIB defines four SMIV2 notification objects:

- NTP Leap Indicator Bits status change
- NTP Stratum change
- GPS Fault Status change
- GPS Time Figure of Merit change

Invocation of the SNMP daemon

The SNMP daemon, **snmpd** is started from the */etc/rc.d/rc.local* system start-up script with this line:

```
snmpd -s -c /etc/snmpd.conf
```

By default, it will listen on port 161 for SNMP queries from the network management system. If you would like to have it listen on another port, you could edit the file by adding **-p port** to the end of this line, where **port** is the number of the port you would like for the agent to listen on. If you would like to disable starting of the **snmpd** daemon altogether, you can either remove this line or place a **#** character at the beginning of the line so that it will not be executed. (A very compact editor with WordStar command keystrokes is available on the system for this purpose: **edit**. If you start **edit** without giving it a file name to open, it will display its help screen, showing the supported keystrokes.)

IMPORTANT

After editing */etc/rc.d/rc.local*, you must copy it to the */boot/etc/rc.d* directory and re-boot the system. It is very important to retain the access mode for the file, so be sure to use **cp -p** when performing the copy. During the boot process, the files contained in the */boot/etc/rc.d* directory are copied to the working */etc/rc.d* directory on the system RAM disk. In this way the factory defaults are overwritten.

Quick Start Configuration -- SNMPv1/v2c

You should be able to compile the TEMPUSLXUNISON-MIB file on your SNMP management system and access the variables defined therein. The factory default community names are “TempusLXUnison” for the read-only community and “endrun_1” for the read-write community. This is all that is required for operation under v1 and v2c of SNMP. You can, and should, change the default community names by editing */etc/snmpd.conf* and modifying these two lines:

```
rwcommunity    endrun_1  
rocommunity    TempusLXUnison
```


Configuring SNMPv1 Trap Generation

To have your Unison send SNMPv1 traps (RFC-1215) you must configure the community and destination for SNMPv1 traps by uncommenting and editing this line in */etc/snmpd.conf*:

```
trapsink      xxx.xxx.xxx.xxx trapcommunity trapport
```

where **trapcommunity** should be replaced by your community, and **xxx.xxx.xxx.xxx** is the IP address or hostname of the destination host for receiving the traps generated by the Unison. By default, the trap will be sent to port 162. You may optionally add another parameter, **trapport** to the end of the above line to override the default port setting. Otherwise leave it blank.

Note: Though the agent will recognize multiple **trapsink** lines within */etc/snmpd.conf* and send the generic SNMP coldStart or authenticationFailure traps to each destination, the enterprise trap generation mechanism of the Unison will only send a trap to the last declared **trapsink** in the file.

Configuring SNMPv2c Notifications and Informs

To have your Unison send SNMPv2c notifications (SMIv2, RFC-2578) or informs, you must configure the communities and destinations by uncommenting and editing one or both of these lines in */etc/snmpd.conf*:

```
trap2sink     xxx.xxx.xxx.xxx trap2community trap2port
informsink    xxx.xxx.xxx.xxx informcommunity informport
```

where **trap2community** and **informcommunity** should be replaced by your communities, and **xxx.xxx.xxx.xxx** is the IP address or hostname of the destination host for receiving the notifications or informs generated by the Unison. By default, the v2c trap or inform will be sent to port 162. You may optionally add another parameter, **trap2port** or **informport** to the ends of the above lines to override the default port setting. Otherwise leave it blank.

Note: Though the agent will recognize multiple **trap2sink** or **informsink** lines within */etc/snmpd.conf* and send the generic SNMP coldStart or authenticationFailure notifications and informs to each destination, the enterprise notification/inform generation mechanism of the Unison will only send a notification to the last declared **trap2sink** and an inform to the last declared **informsink** in the file.

IMPORTANT

After editing */etc/snmpd.conf*, you must copy it to the */boot/etc* directory and re-boot the system. It is very important to retain the access mode for the file (readable only by *root*), so be sure to use **cp -p** when performing the copy. During the boot process, the files contained in the */boot/etc* directory are copied to the working */etc* directory on the system RAM disk. In this way the factory defaults are overwritten.

Configuration of SNMPv3

If you are planning to use SNMPv3, you should definitely make use of the two resources mentioned previously (UCD-SNMP website and *Essential SNMP*) and study them carefully. There are rather elaborate configuration options available when you are using v3. The instruction presented here will

give you the flavor of the configuration but definitely not the full scope of possibilities. To access your Unison via v3 of SNMP, you will have to configure two files:

```
/etc/snmpd.conf
/boot/ucd-snmp/snmpd.conf
```

The first file contains static configuration parameters that the agent uses to control access and to determine where to send notifications/traps. Other aspects of the agent's operation are also configurable in this file, but you should not need to modify those. To use the SNMPv3 capabilities of the Unison, you must first set up user information and access limits for those users in */etc/snmpd.conf*. Uncomment and edit these two lines to define your v3 users and their access parameters:

```
rwuser root      priv .1
rouser ntpuser  auth .1.3.6.1.4.1.13827
```

The first line defines a SNMPv3 read-write user *root* whose minimum security level will be authenticated and encrypted for privacy (choices are noauth, auth and priv), and who will have read-write access to the entire *iso(1)* branch of the SMI object tree. The second line defines a SNMPv3 read-only user *ntpuser* whose minimum security level will be authenticated but not encrypted, and who will have read-only access to the entire *iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).endRun-TechnologiesMIB(13827)* branch of the SMI object tree. After adding the user lines to */etc/snmpd.conf*, copy it to the */boot/etc* directory using **cp -p**.

The second file is located on the non-volatile FLASH disk and is used by the SNMP agent to store “persistent data” that may be dynamic in nature. This may include the values of the MIB-II variables *sysLocation*, *sysContact* and *sysName* as well as any configured SNMPv3 user crypto keys. In order to use SNMPv3, you must configure user keys in this file for each SNMPv3 user that you have set up in */etc/snmpd.conf*. To do this, you must add lines to */boot/ucd-snmp/snmpd.conf* like these for each user:

```
createUser root      MD5 endrun_1 DES endrun_1
createUser ntpuser  SHA Tempus_0
```

The first line will cause the agent, **snmpd** to create a user *root* who may be authenticated via Message Digest Algorithm 5 (MD5) with password *endrun_1* and may use the Data Encryption Standard (DES) to encrypt the session data with passphrase *endrun_1*. The second line will cause a user *ntpuser* to be created who may be authenticated using the Secure Hash Algorithm (SHA) with password *Tempus_0*. Passwords and passphrases must have a *minimum* of 8 characters, or you will not be able to be authenticated.

IMPORTANT

You must kill the **snmpd** process prior to editing, */boot/ucd-snmp/snmpd.conf*. Otherwise, the secret key creation may not complete properly. Issue the command **ps -e** to have the operating system display the list of running processes. Look for the PID of the **snmpd** process and issue the kill command to stop it. For example, if the PID listed for the **snmpd** process is 53, then you would issue this command: **kill 53**. You can verify that the process was terminated by re-issuing the **ps -e** command.

After re-booting, the agent will read the */boot/ucd-snmp/snmpd.conf* configuration file and compute

secret key(s) for each of the users and delete the **createUser** lines from the file. It will then write the secret key(s) to the file. These lines begin with the string, **usmUser**. In this way, un-encrypted passwords are not stored on the system.

IMPORTANT

The encryption algorithms used by the agent are dependent upon the IP address of the Unison. Because of this, new keys must be generated anytime your Unison's IP address is changed. It also means that you cannot use the same **/boot/ucd-snmp/snmpd.conf** file with multiple Unison units. To generate new keys, stop the **snmpd** process, delete the existing **usmUser** key lines from the file and then add new **createUser** lines. Then re-boot the system.

This example gives the simplest configuration to begin using SNMPv3 but doesn't make use of the full capabilities of the VACM in defining groups and views for fine-grained access control. The factory default **/etc/snmpd.conf** file contains commented blocks of lines that can be uncommented to give you a basic configuration that uses the User-based Security Model (USM) described in RFC-2274 and the View-based Access Control Model (VACM) described in RFC-2275. The comments included in the file should help you in modifying it for your specific requirements.

Appendix D

GPS Reference Position

*Your Unison is capable of operation from either an automatically determined GPS reference position or a manually entered GPS reference position. If your Unison is unable to automatically determine this information itself, this appendix describes the needed background information and procedures for determining an acceptably accurate GPS reference position in the proper **World Geodetic Survey of 1984 (WGS-84) geodetic datum**. Refer to the **Geodesy** and **WGS-84 Positions** sections of this appendix for details on some of the jargon contained herein.*

Obtaining Reference Positions

If you need to provide an accurate (< 100 meter error) reference position to your Unison because you are using a window-mounted antenna with inadequate satellite visibility, there are two good ways to do it: 1) use a handheld GPS receiver to obtain a position near the location of your Unison antenna or 2) reference a geodetic database to obtain a position for your street address. The first way is the easiest and probably the best:

Using a Handheld GPS Receiver

Obtain an inexpensive, handheld GPS receiver. Use it outside of the building to determine a position that is within 100 meters of the installed Unison antenna. Make sure that the handheld GPS receiver is configured to report its positions in the WGS-84 datum. Record the position and then make any adjustments to the height that might be necessary if the antenna is installed in a high-rise building. Input it to the Unison via the `setgpsrefpos` command.

Using Geodetic Databases

Many users will not feel confident in determining their own reference position via this technique. For those users, EndRun Technologies technical support will be happy to assist you. We are familiar with the procedure and can convert your street address and zipcode information to the proper WGS-84 coordinates for you. The following provides the necessary background information needed to interpret the geodetic database and then describes the procedure:

Geodesy: Geodesy is the science of mathematically describing the earth's surface. To do this, a model or *geodetic datum* is used to fit the shape of the earth. These models are flattened spheres called *ellipsoids*. The earth's shape is accurately modeled using such an ellipsoid, with the equator being a circle around the fattest part and with the north and south poles corresponding to the compressed top and bottom of the ellipsoid. Some of these models are intended only for localized regions of the earth's surface. The GPS uses a model that is called the WGS-84 ellipsoid. It is intended to model the entire earth, and is currently the best global model available.

What these ellipsoids are actually attempting to approximate is the *geoid*. The geoid is a gravitationally equipotential surface surrounding the earth that is everywhere perpendicular to the gravitational field and approximates the surface of the oceans. The height of the surface of the geoid relative to the

surface of the WGS-84 ellipsoid is called the *geoid height* or *separation* and has been determined by literally millions of gravitational measurements performed over its entire surface. Due to variations in the distribution of mass concentration of the earth, the geoid height varies over a range of about 100 meters. The simplicity of the ellipsoid model cannot describe these fluctuations, so the precise, survey-quality description of the geoid height is contained in a very large data base. This database can be accessed via a utility called GEOID99 that is freely available from the NGS/NOAA website. Over most of North America, the geoid height is *negative* which means that it lies *below* the surface of the WGS-84 ellipsoid.

The height above the ellipsoid of a point P is called the ellipsoidal height, h of P. The height above the geoid of a point P is called the orthometric height, H . The orthometric height is also commonly known as the height above mean sea level. The geoid height at point P is referred to as N . h , H and N are related using this equation: $h = H + N$.

A wealth of information on this subject, as well as conversion programs and databases are available at the National Geodetic Survey/National Oceanic and Atmospheric Administration and the National Imagery and Mapping Agency (formerly the Defense Mapping Agency) websites:

<http://www.ngs.noaa.gov>
<http://164.214.2.59/GandG/pubs.html>

WGS-84 Positions: Internally, GPS receivers perform all of their range measurement calculations using receiver and satellite positions that are kept in a Cartesian, XYZ coordinate system. The center of the earth, as modeled by the WGS-84 ellipsoid, is the origin for the coordinates. The X-axis lies in the equatorial plane and intersects the 0° or Greenwich meridian. The Y-axis also lies in the equatorial plane and intersects the 90° east meridian. The Z-axis is perpendicular to the equatorial plane and is the polar axis. The WGS-84 ellipsoid is simple to describe mathematically and facilitates the calculations that take place in a GPS receiver to convert Cartesian XYZ coordinates to latitude, longitude and height above the WGS-84 ellipsoid.

However, for a lot of reasons WGS-84 is not the geodetic datum that has been universally used by mapmakers and surveyers. That means that to use positions generated by a GPS receiver to find a location on a map, a conversion between the GPS WGS-84 position and the geodetic datum used for making the map must be performed. Sometimes the differences are small, as in using a localized datum known as the North American Datum of 1983 (NAD-83). The positional differences between WGS-84 and NAD-83 are only at the one meter level, so for our purposes you can use NAD-83 and WGS-84 interchangeably. The older North American Datum of 1927 (NAD-27) exhibits much larger differences, mostly in the longitude, that can exceed 100 meters. Many maps and survey benchmarks exist that were created using this datum.

Procedure: Access a mapping database, of which there are several on the Internet, that will convert a street address and zipcode to latitude and longitude. In general, the datum for the latitude and longitude will not be WGS-84. In the United States it will likely be NAD-27. If so, you must convert this to NAD-83 using a utility called NADCON that is freely downloadable from the NGS/NOAA website. NAD-83 is sufficiently close to WGS-84 that we can use coordinates from either geodetic datum interchangeably.

Having the horizontal position coordinates, you now need to determine a height above the WGS-84 ellipsoid for your location. To do that, you need to find a survey benchmark near your location

GPS REFERENCE POSITION

and make the assumption that its height is close to your street height. From the same NGS/NOAA website, you can obtain a list of survey benchmarks that are within a user-specified radius of the NAD-83 latitude and longitude coordinates you previously determined. Of these, some are vertical control points, meaning that they have height data as well as latitude and longitude data. You can select one, or several of these that are closest to your location and download the datasheets for those benchmarks.

Some of these vertical control point datasheets are based on GPS survey measurements and contain the height above the NAD-83 ellipsoid information. If so, then you can use that height directly along with the NAD-83 latitude and longitude coordinates you previously determined. Other vertical control point datasheets will give only the orthometric height, which is the height above the geoid. Fortunately, the height of the geoid above the WGS-84 ellipsoid is also contained in the datasheet. So, to obtain the height above the ellipsoid you must add the orthometric height and the geoid height together. Make any adjustments to the height that might be necessary if the antenna is installed in a high-rise building. Armed with coordinates in the NAD-83 datum, you can input them to the Unison via the **setgpsrefpos** command.

The following is a sample datasheet for a benchmark that is near the EndRun Technologies facility in downtown Santa Rosa, CA:

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 6.57
1      National Geodetic Survey,  Retrieval Date = JANUARY 23, 2002
JT9450 *****
JT9450 DESIGNATION - B 1397
JT9450 PID - JT9450
JT9450 STATE/COUNTY- CA/SONOMA
JT9450 USGS QUAD - SANTA ROSA (1994)
JT9450
JT9450 *CURRENT SURVEY CONTROL
JT9450
JT9450 * NAD 83(1986)- 38 26 44. (N) 122 43 25. (W) SCALED
JT9450 * NAVD 88 - 47.270 (meters) 155.09 (feet) ADJUSTED
JT9450
JT9450 GEOID HEIGHT- -31.28 (meters) GEOID99
JT9450 DYNAMIC HT - 47.241 (meters) 154.99 (feet) COMP
JT9450 MODELED GRAV- 980,011.6 (mgal) NAVD 88
JT9450
JT9450 VERT ORDER - FIRST CLASS II
JT9450
JT9450.The horizontal coordinates were scaled from a topographic map and have
JT9450.an estimated accuracy of +/- 6 seconds.
JT9450
JT9450.The orthometric height was determined by differential leveling
JT9450.and adjusted by the National Geodetic Survey in June 1991.
JT9450
JT9450.The geoid height was determined by GEOID99.
JT9450
JT9450.The dynamic height is computed by dividing the NAVD 88
JT9450.geopotential number by the normal gravity value computed on the
JT9450.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
JT9450.degrees latitude (g = 980.6199 gals.).
JT9450
JT9450.The modeled gravity was interpolated from observed gravity values.
JT9450
JT9450; North East Units Estimated Accuracy
JT9450;SPC CA 2 - 586,710. 1,936,830. MT (+/- 180 meters Scaled)
JT9450
JT9450 SUPERSEDED SURVEY CONTROL
```

APPENDIX D

```
JT9450
JT9450  NGVD 29      -      46.412  (m)      152.27  (f) ADJUSTED      1 2
JT9450
JT9450.Superseded values are not recommended for survey control.
JT9450.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JT9450.See file dsdata.txt to determine how the superseded data were derived.
JT9450
JT9450_MARKER: DB = BENCH MARK DISK
JT9450_SETTING: 38 = ABUTMENT
JT9450_STAMPING: B 1397 1987
JT9450_MARK LOGO: NGS
JT9450_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
JT9450
JT9450  HISTORY      - Date      Condition      Report By
JT9450  HISTORY      - 1987      MONUMENTED      NGS
JT9450
JT9450                                     STATION DESCRIPTION
JT9450
JT9450'DESCRIBED BY NATIONAL GEODETIC SURVEY 1987
JT9450'IN SANTA ROSA.
JT9450'IN SANTA ROSA, AT THE INTERSECTION OF U.S. HIGHWAY 101 AND STATE
JT9450'HIGHWAY 12, SET VERTICALLY IN THE SOUTH FACE OF THE NORTH CONCRETE
JT9450'ABUTMENT OF THE SOUTHBOUND U.S. HIGHWAY OVERPASS OF THE STATE
JT9450'HIGHWAY, 6.7 M (22.0 FT) WEST OF THE CENTER OF THE SOUTHBOUND LANES
JT9450'OF THE U.S. HIGHWAY, 5.6 M (18.4 FT) NORTH OF THE CENTERLINE OF THE
JT9450'WESTBOUND LANES OF THE STATE HIGHWAY, AND 0.3 M (1.0 FT) EAST OF THE
JT9450'WEST END OF THE ABUTMENT.
JT9450'THE MARK IS 1.4 M ABOVE A SIDEWALK.

*** retrieval complete.
Elapsed Time = 00:00:01
```

The height data for this benchmark was not obtained via GPS and so does not directly contain height above the ellipsoid, but we can obtain that information by adding the orthometric height (47.27 meters) to the geoid height (-31.28 meters). In this case, the ellipsoid height of the benchmark is 15.99 meters. This benchmark is .4 miles from the EndRun Technologies facility. The GPS antenna at the facility is located on the rooftop of a three story office building which would place it about 15 meters above the street level. If we add 15 meters to the benchmark height we estimate the antenna height at 30.99 meters.

The GPS receiver actually reports a WGS-84 height of 32 meters, which gives remarkably close agreement. In general, you should not expect results that are this good. Downtown Santa Rosa is located on a very flat plain so that relatively distant survey points give acceptable results. You should exercise some judgment in selecting particular survey points to use for your location. As an example, if you know that the terrain west of your facility rises or falls rapidly you should avoid using benchmarks that are west of your facility.

Appendix E

Time Figure-of-Merit (TFOM)

*This appendix describes the Time Figure of Merit (TFOM) number. The Unison displays this number in the time-of-day fields printed by the Unison **gpsstat** and **gntpstat** commands (see Chapter 5). The TFOM number indicates the level of accuracy that should be included in the interpretation of the time-of-day and ranges from 4 to 9:*

4	time error is < 1 us
5	time error is < 10 us
6	time error is < 100 us
7	time error is < 1 ms
8	time error is < 10 ms
9	time error is > 10 ms, unsynchronized state if never locked to GPS

In all cases, the Unison reports this value as accurately as possible, even during periods of GPS signal outage where the Unison is unable to directly measure the relationship of its timing outputs to UTC. During these GPS outage periods, assuming that the Unison had been synchronized prior to the outage, the Unison extrapolates the expected drift of the Unison timing signals based on its knowledge of the characteristics of the internal Temperature Compensated Crystal Oscillator (TCXO), Oven Controlled Crystal Oscillator (OCXO) or Rubidium oscillator. The extrapolated TFOM is based on a conservative estimate of the performance of the oscillator and should be considered ‘worst case’ for a typical benign ambient temperature environment.

Due to this extrapolation behavior, after initial synchronization, brief periods without GPS satellite visibility will not induce an immediate alarm condition. (Removal of the antenna to simulate this will induce an immediate alarm, however.) If the condition persists for long enough periods, you should see the TFOM character change to indicate a gradually deteriorating accuracy of the timing outputs. If the signal loss condition persists longer, then the final, unsynchronized state will eventually be reached. If the Unison is unable to achieve re-synchronization within one hour after reaching this state, the red LED will illuminate. The fault status field returned in either of the **gpsstat** or **gntpstat** commands will have the appropriate bit set to indicate a loss-of-signal time-out condition.

If the GPS subsystem reaches the unsynchronized TFOM state, the NTP daemon will cease to use the timing information returned by the GPS subsystem in its polling event timestamps. At this point, the NTP daemon will report in its replies to network NTP clients that it is running at stratum 16 and the leap indicator bits will be set to the fault state. NTP clients will recognize that and cease to use the unsynchronized server.

Appendix F

Specifications

GPS Receiver:

- L1 Band – 1575.42 MHz
- 8 Channels, C/A Code

Antenna:

- TNC jack on rear panel, $Z_{in} = 50\Omega$
- Integral +35 dB gain LNA with bandpass filter for out-of-band interference rejection.
- Rugged, all-weather housing capable of operation over -40°C to $+85^{\circ}\text{C}$ temperature extremes
- Mounting via 18" long, $\frac{3}{4}$ " PVC pipe with stainless steel clamps.
50' low-loss RG-59 downlead cable standard.
- Extension cables and low noise pre-amplifiers are available as options.

Local Oscillator:

- TCXO is standard (2.5×10^{-6} over -20° to 70°C).
- Option: Medium-Stability OCXO (4×10^{-9} over 0 to 70°C).
- Stratum 1 Holdover Performance: 24 Hours - TCXO
35 Days - MS-OCXO

Time to Lock:

- < 5 minutes, typical (TCXO).
- < 10 minutes, typical (OCXO).

Network I/O:

- Rear panel RJ-45 jack
- AMD PC-Net Fast III 10/100Base-T ethernet

System Status Indicator:

- **Sync LED:** Green LED pulses to indicate CDMA acquisition and lock status.
- **Network LED:** Amber LED indicates network activity.
- **Alarm LED:** Red LED indicates a fault condition.

Linux Maintenance Console:

- RS-232 serial I/O on rear panel DB9M plug for secure, local terminal access.
- Parameters fixed on 19200 baud, 8 data bits, no parity, 1 stop bit.
- For communication with another computer, 2 meter DB9F-DB9F null modem adapter cable is included.

Synchronization Accuracy:

- GPS Receiver Accuracy: <10 nanoseconds to GPS Time when locked.*
- NTP Timestamp Accuracy: <10 microseconds @ 200 packets/second (200,000 clients).
- NTP Client Synchronization Accuracy: Network factors can limit LAN synchronization accuracy to 1/2 to 2 milliseconds, typical.

* <100 nanoseconds to UTC. Constraints in the official GPS specification prohibit anyone from claiming an accuracy to UTC better than 100 nanoseconds.

Supported Protocols:

- SNTP, NTP v2, v3, v4 and broadcast/multicast mode; MD5 authentication
- SSH server with “secure copy” utility, SCP
- SNMP v1, v2c, v3 with Enterprise MIB
- TIME and DAYTIME server
- TELNET client/server
- FTP client
- DHCP client

Power:

- 85-270 VAC, 47-63 Hz, .5 A Max. @ 120 VAC, .25 A Max. @ 240 VAC
- 110-370 VDC, 0.5A Max @ 120 VDC
- 3-Pin IEC 320 on rear panel, 2 meter line cord is included.

DC Power (option):

- 38-72 Vdc, 1.5A maximum.
- 3-position terminal block on rear panel: +DC IN, SAFETY GROUND, -DC IN
(Floating power input: Either “+” or “-” can be connected to earth ground.)

Size:

- **Chassis:** 1.75”H x 17.0”W x 10.75”D
- **Antenna:** 3.5” Dia. x 2.5” H
- **Weight:** < 5 lb. (2.70 kg.)

Environmental:

- **Temperature:** 0° to +50°C
- **Humidity:** 0 to 95%, non-condensing

Optional Output:

See *Chapter 2 - Physical Description* for more information on this output.

- **Alarm:** MMBT2222A open collector, grounded emitter. High impedance in alarm state.

Voltage: 40 VDC, maximum.

Saturation Current: 100 mA, maximum.

Connector: Rear-panel BNC jack or terminal strip.

CE/FCC Compliance: RTTE Directive 99/5/EC
Low Voltage Directive 73/23/EC
EMC Directive 89/336/EC
With Amendment 93/68/EC

Supplementary Compliance Data:

- **Safety:** EN 60950:1992, A1,A2: 1993, A3: 1995, A4: 1997, A11:1998
- **EMC:** EN 55024:1998 w/ A1:2000 and A2:2003, EN61000-3-2:2000, EN61000-3-3:1995 w/ A1:2001, EN55022:1998 Class A, VCCI (April 2004) Class A, FCC Part 15 Subpart B Class A, ICES-003 Class A.



DECLARATION OF CONFORMITY

(According to ISO/IEC GUIDE 22 and EN 45014)

Manufacturer's Name: EndRun Technologies

**EndRun
TECHNOLOGIES**

Manufacturer's Address: 1360 North Dutton Avenue, Suite 200
Santa Rosa, CA 95401, U.S.A.

DECLARES THAT THE PRODUCT

Product Name: (1) Network Time Servers and (2) Time & Frequency Standards

Model Number: (1) Tempus LX GPS, Tempus LX CDMA, Unison GPS, Unison CDMA; and (2) Tycho GPS, Tycho CDMA

CONFORMS TO THE FOLLOWING EUROPEAN DIRECTIVES

RTTE Directive 99 / 5 / EC
Low Voltage Directive 73 / 23 / EC
EMC Directive 89 / 336 / EC
With Amendment 93 / 68 / EC

Supplementary Information:

Safety : EN 60950: 1992, A1,A2: 1993, A3: 1995, A4: 1997, A11:1998
EMC: EN 55024:1998 w/ A1:2000 and A2:2003, EN61000-3-2:2000,
EN61000-3-3:1995 w/ A1: 2001, EN55022:1998 Class A,
VCCI (April 2004) Class A, FCC Part 15 Subpart B Class A,
ICES-003 Class A

Year Mark First Applied: 2004

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards.

Place: Santa Rosa, California USA

Signature:

Date: December 22, 2004

Full Name: David J. Lobsinger

Position: V. P. Hardware Engineering

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