EndRun TECHNOLOGIES
"Smarter Timing Solutions"

RTM3204

GPS Timing Module

User Manual

RTM3204 GPS *Timing Module*

User Manual

Preface

Thank you for purchasing the RTM3204 GPS Timing Module. Our goal in developing this product is to bring you a precise time and frequency reference that will quickly, easily and reliably meet or exceed your system requirements. Your new RTM3204 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.

Trademark Acknowledgements

Part No. USM3204-0100-000 Revision 4
February 2012

About This Manual

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

Introduction – The RTM3204 GPS Timing Module, how it works, where to use it, its main features.
Basic Installation – How to connect, configure and test your RTM3204 GPS Timing Module.
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 two 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 send product to EndRun Technologies and EndRun Technologies shall pay shipping charges to return product to Buyer. However, if returned product proves to be operating normally (not defective) then Buyer shall pay for all shipping charges. If Buyer is located outside the U.S.A. then Buyer shall pay all duties and taxes, if any.

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.

Limitation of Warranty

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

TO THE EXTENT PERMITTED BY LAW, THIS WARRANTY AND REMEMDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, REMEDIES AND CONDITIONS WHETHER ORAL OR WRITTEN, STATUTORY, EXPRESS, OR IMPLIED. AS PERMITTED BY APPLICABLE LAW, ENDRUN SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY OR 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.

Loaner units are not included as part of the standard warranty.

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 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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Table of Contents

Chapter*One*

Introduction

The RTM3204 is a derivative of our standard product, the Tycho GPS Frequency Reference. As such, the software operating system interface will contain references to Tycho GPS. The RTM3204 GPS Timing Module includes 1 PPS, 10M PPS, and IRIG-B as standard outputs plus an RS-232 serial port. In addition, a network port which includes many protocols including TELNET, FTP, DHCP, SNMP, HTTP and SSH is a standard feature.

The RTM3204 GPS Timing Module utilizes the GPS transmissions to precisely synchronize itself to Universal Coordinated Time (UTC) to the 100-nanoseconds level of accuracy. The frequency of the internal oscillator is disciplined to match the frequency of the UTC timescale to better than 10^{-13} level of accuracy over 24-hour observation intervals. The time and frequency outputs are coherent after initial GPS synchronization, and synchronization is maintained via 20-bit DAC frequency control, rather than phase stepping, to provide excellent short-term stability.

Main Features

Overview

The Timing Module 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, an RS-232 serial port, a High-Performance Rubidium (Rb) oscillator, and a power supply. Non-volatile storage of the embedded Linux operating system and the application software is via FLASH memory.

Standard Features

In addition to sourcing precision 1PPS and 10MPPS timing references and an IRIG-B timecode output, your Timing Module includes a serial port and a network port. The RTM3204 can be managed via the network port or a local console on the RS-232 serial port. See ***Chapter 3 - Control and Status Commands*** for more information.

Secure Network Interface

An ethernet port is provided as a standard feature of the RTM3204 GPS Timing Module with a wide variety of protocols including SNMP with Enterprise MIB, SSH, TELNET, HTTP, and FTP. Refer to ***Chapter 2 - Basic Installation*** for information to help you set up your network interface. The inclusion of SNMP v3 and SSH provides a very secure network interface and allows you to safely perform monitoring and maintenance activities over the network. Security-conscious users can also disable any or all of the risky protocols such as HTTP, Telnet, Time and Daytime. In addition, access via SSH, SNMP and Telnet can be restricted to specific hosts. Refer to ***Appendix C - SNMP*** and ***Appendix D - Security*** for further information.

Free FLASH Upgrades

Firmware and configurable hardware parameters are stored in non-volatile FLASH memory, so the Timing Module can be easily upgraded in the field using HTTP, 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. For firmware upgrade procedures refer to ***Appendix B - Upgrading the Firmware***.

GPS Timing-How It Works

The time and frequency engine in the RTM3204 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 RTM3204 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 RTM3204 GPS Timing Module virtually anywhere. However, you must be able to install an antenna with good sky visibility, preferably on the rooftop. Once continuously synchronized for at least 3 days, the Timing Module can maintain microsecond-level accuracy for about 24 hours without GPS reception, by flywheeling on its Rubidium oscillator (Rb). If using the TCXO option this specification is greatly reduced - to the 10-millisecond level of accuracy.

Chapter *Two*

Basic Installation

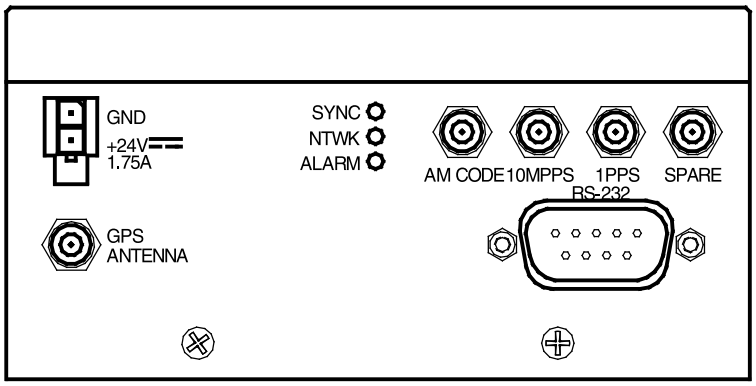
This chapter will guide you through the most basic checkout and physical installation of your RTM3204 GPS Timing Module. Subsequent chapters and appendices will give you the information needed to configure your installation for the maximum performance in your operating environment. Though some familiarity with Linux or other Unix-like operating systems would be helpful, it is not essential. When operating your Timing Module with its standard network interface, basic familiarity with TCP/IP networking protocols like **`ping`**, **`telnet`** *and* **`ftp`** *is required.*

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 RTM3204 GPS Timing Module shipment typically contains:

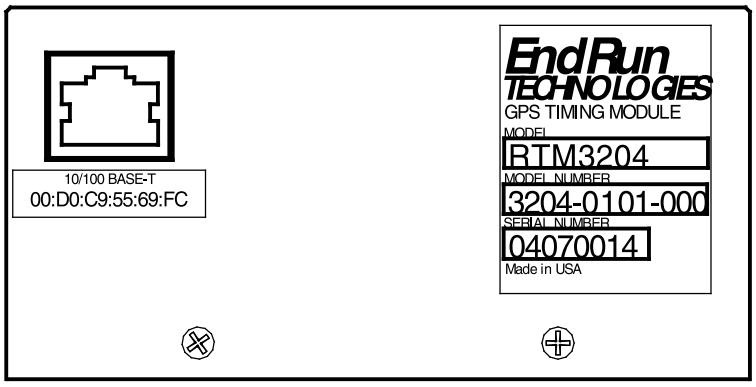
- RTM3204 GPS Timing Module (part # 3204-0101-000 or #3204- variant)
- RTM3204 User Manual (part # 3204-0100-000) on CD (part # 5102-0001-000)
- Basic Cable Kit (part # 0648-0002-000) including:
  - RJ-45 to RJ-45 CAT-5 patch cable, 2 meters
  - DB9F-to-DB9F null-modem serial I/O cable
- Antenna Kit (part # 0610-0010-001) including:
  - GPS antenna
  - Pipe/clamps for outside antenna mounting
  - Inside window-mount kit
  - 50’ TNC/BNC RG-59/U coaxial cable assembly
- Starter Kit (part # 0608-0003-001) including:
  - 6” SMB/BNC adaptor cable (qty 2)
  - DC power connector and crimp pins
  - 36” DC power cable

Physical Description



FRONT PANEL

Sync LED	This green LED flashes to indicate synchronization status.
Network LED	This amber LED illuminates when the RTM32304 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 SMB connector mates with the downlead cable from the external antenna.
RS-232 Connector	This DB-9M connector provides the RS-232 serial I/O console interface to the RTM3204. This console allows the user to initialize and maintain the RTM3204. See ***Chapter 3 - RS-232 Serial I/O Port Signal Definitions*** for detailed information.
1PPS Jack	This SMB connector provides the 1PPS TTL output. The pulse width is normally 1 millisecond wide when shipped from the factory but can be changed via console command **`cpuoptsconfig`**. Other selections are 20 microseconds, 100 milliseconds and 500 milliseconds. See signal definition in ***Appendix H - Specifications*** for the 1PPS output.
10MPPS Jack	This SMB connector provides the 10MPPS TTL output. See signal definition in ***Appendix H - Specifications*** for more information.
AM Code Jack	This SMB connector provides the amplitude-modulated timecode output. The timecode output is normally IRIG-B122 when shipped from the factory, but can be changed via the console command **`cpuoptsconfig`**. Other selections are IRIG-B123, IRIG-B IEEE-1344 compliant, NASA-36 and 2137. See signal definition in ***Appendix H - Specifications*** for the AM Code output.



REAR PANEL

Spare Jack	This spare is for the optional Fixed Rate Output or 10 MHz Low-Phase-Noise Output.
DC Power Input Jack	This 2-position jack provides connection to the DC power source. See details in ***Appendix H - Specifications.***
10/100Base-T Jack	This rear-panel RJ-45 connector mates with the ethernet twisted pair cable from the network.

Performing an Initial Site Survey

Using the status LED indicators, it's easy to find out if your RTM3204 will work in your desired location:

1. Mount the antenna on the roof using the supplied mounting hardware. Make sure that it is not blocked by large metallic objects closer than one meter.

2. Connect the BNC plug on the end of the antenna cable to the supplied BNC jack to SMB plug adapter cable. Connect the SMB plug end of the adapter cable to the antenna input jack on the RTM3204 GPS Timing Module.

3. Connect the "+24VDC" terminal to the positive output of the DC power source. Connect the "GND" terminal to the negative output of the DC power source. The DC power source voltage must not exceed +32V. This unit will not operate if the +/- connections are reversed; however it will not be damaged by a reverse connection. Note that the GND terminal is connected to the chassis inside the unit.

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. Note: If your unit has a Rubidium oscillator upgrade then it will need 5-10 minutes of warmup before trying to acquire a signal.

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 mount the RTM3204 and its antenna in their desired locations. If you are unable to achieve GPS lock after 24 hours call Customer Support (1-877-749-3878) for assistance.

Installing the RTM3204 GPS Timing Module

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmul interference in which case the user will be required to correct the interference at his own expense.

Mount the RTM3204 GPS Timing Module

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. Refer to the baseplate drawing in ***Appendix H - Specifications*** for the mounting hole locations.

CAUTION

The RTM3204 internal temperature must not exceed 70°C, as measured by the built-in temperature sensor accessible via the "oscctrlstat" serial port command. Internal temperature will remain in safe range if all conditions are met:

A. Base plate is in good thermal contact with external enclosure.

B. Ambient air temperature surrounding RTM3204 GPS Timing Module enclosure is $< 50°C$.

C. Adequate clearance around RTM3204 enclosure allows for free-convection around cover.

D. No additional thermal sources via adjacent mechanical contact.

Condition A must be met. If condition B and/or C and/or D cannot be met as stated, use built-in temperature sensor to verify adequate operating margins.

Connecting and Configuring Ethernet

Connect one end of the CAT-5 patch cable supplied with your RTM3204 to the 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 RTM3204 will attempt to configure the ethernet interface automatically via the Dynamic Host Configuration Protocol (DHCP). The RTM3204 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 RTM3204 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 RTM3204 up and running, you may procede 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 RTM3204 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 RTM3204 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 RTM3204.

To test serial communications with the RTM3204 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 RTM3204.

2. Connect one end of the DB9F-to-DB9F null modem adapter cable to the serial I/O jack on the RTM3204.

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 3 - 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 RTM3204 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 RTM3204. (The RTM3204 is a derivative of our Tycho GPS Frequency Reference. As such, all the Linux scripts will contain references to the Tycho GPS.) 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 RTM3204/Tycho 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
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:

```
Tycho 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 System Time daemon...
Starting the SNMP daemon...
Starting the system logfile manager...
Starting the system watchdog...woof!
```

During this process, the factory default TychoGPS_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 RTM3204/Tycho login prompt is displayed:

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

gsys login:
```

Here you may log in as “gsysuser” with password “Praecis” or as the “root” user with password “endrun_1”. When logged in as “gsysuser”, 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 Tycho GPS and shows the software part number, version and build date:

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

This last line is the standard RTM3204/Tycho shell prompt. The RTM3204/Tycho uses the **`bash`** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **`gsyspasswd`** 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 4 - RS-232 Serial I/O Port Signal Definitions*** for the signal connections for the RTM3204.

NOTE

You must use a null-modem cable or adapter if you are connecting the RTM3204 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 RTM3204, you may procede to configuring the network parameters. Then you can communicate with the RTM3204 over the network using **telnet** or **ssh**.

Using netconfig to Set Up Your IP

The script file **netconfig** will configure the TCP/IP network parameters for your RTM3204. If you want to have the HTTP Interface enabled in your RTM3204 then be sure to configure the name server IP address during the **netconfig** process. The HTTP Interface will not start if this is configured incorrectly. Only one name server is required, two gives some redundancy.

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:

```
Tycho GPS (root@gsys)-> netconfig

*******************************************************************************
******************** Tycho GPS Network Configuration  *************************
*******************************************************************************
*                                                                             *
*   This script will configure the TCP/IP network parameters for your         *
*   Tycho 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     *
*   Tycho 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.                *
*                                                                             *
*******************************************************************************
*******************************************************************************

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

---HOST name setting

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

---DOMAIN name setting

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

```
---STATIC IP ADDRESS setting

Set the IP address for the Tycho GPS. Example: 111.112.113.114
Enter IP address for gsys (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 Tycho GPS's current IP address, full hostname, and base hostname:
192.168.1.245       gsys.your.domain    gsys

---DOMAIN NAMESERVER(S) address setting

Will your Tycho 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 Tycho 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 Tycho 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 RTM3204 and reboot it. There are two ways to do this:

1. Cycle power to the RTM3204.

2. Issue the shutdown with reboot command at the shell prompt:

```
Tycho GPS (root@gsys:~)-> shutdown -r now
```

If you are using the RS-232 serial I/O port to communicate with the RTM3204, you will be able to see the kernel generated boot messages when the unit reboots. 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 RTM3204/Tycho 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 RTM3204 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`**:

```
Tycho GPS (root@gsys:~)-> 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`**:

```
Tycho GPS (root@gsys:~)-> 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 RTM3204 has been successfully configured to operate on your network and you are ready to check operation of the RTM3204 over the network. If not, you should recheck 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:

```
Tycho GPS (root@gsys:~)-> 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 RTM3204 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 RTM3204. Alternatively, you could **`ping`** one of your servers or workstations from the RTM3204/Tycho shell prompt to test the setup.

Once you have successfully established network communications with the RTM3204, you may perform all maintenance and monitoring activities via **`telnet`** and **`ftp`**. The RTM3204/Tycho provides both client and server operation using **`telnet`**. For security reasons as well as to reduce the memory footprint in the RTM3204/Tycho, 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 RTM3204/Tycho. Both of these protocols are supported in the RTM3204 via the OpenSSH implementations for Linux. Refer to ***Appendix D - Security*** for more information about the secure shell protocol.

Using Telnet

When establishing a **`telnet`** connection with your RTM3204, 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 RTM3204, this banner will be displayed:

```
*******************************************************************************
*           Welcome to Tycho GPS telnet console on:  gsys.your.domain
*******************************************************************************

gsys login:
```

Here you may log in as “gsysuser” with password “Praecis”. When logged in as “gsysuser”, 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 Tycho GPS and shows the software part number, version and build date:

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

This last line is the standard RTM3204/Tycho shell prompt. The RTM3204/Tycho uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **gsyspasswd** command issued from the shell prompt.

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

```
Tycho GPS (root@gsys:~)-> 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 RTM3204, logging in directly as *root* is permitted. When you log in as *root* via a **ssh** session with the RTM3204, this banner will be displayed:

```
*****************************************************************************
*             Welcome to Tycho GPS SSH console on:  gsys.your.domain
*****************************************************************************

root@gsys.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 Tycho and shows the software part number, version and build date:

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

This last line is the standard RTM3204/Tycho shell prompt. The RTM3204/Tycho uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **gsyspasswd** command issued from the shell prompt.

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

Using HTTP

You may monitor the status of the RTM3204 via the HTTP interface. For security reasons, you may not change any settings via the HTTP interface. See ***Chapter 4 - HTTP Interface*** for more information.

IMPORTANT

SSH, Telnet, SNMP and HTTP are all enabled with default passwords. To ensure security, change the passwords or disable the protocols.

To change the passwords for SSH, Telnet and HTTP use the **gsyspasswd** command. To change the passwords/community strings for SNMP see ***Appendix C - SNMP***.

To disable Telnet use the **inetdconfig** command. To disable SSH, SNMP and HTTP see ***Appendix D - Security, Disabling Protocols***.

Connecting Instruments to the RTM3204

Front-panel mounted SMB jacks provide the means of connecting your equipment to the RTM3204. The standard RTM3204 provides two precision output signals capable of driving properly terminated coaxial cables: 1PPS and 10MPPS. These signals are DC-coupled and sourced from Advanced CMOS (ACMOS) drivers which are able to maintain output TTL levels into a 50-ohm load. The third signal, AM Code, provides a DC-coupled Vrms amplitude-modulated timecode signal into a 50-ohm load. Care should be taken not to short circuit these outputs or to connect them to other voltage sources.

Chapter *Three*

Control and Status Commands

This chapter describes the RTM3204 control and status commands. The RTM3204 supports several application-specific commands for performing initialization/setup and for monitoring the performance and status of the unit. You do not need knowledge of Linux commands in order to operate the RTM3204. However, the RTM3204 does support a subset of the standard Linux shell commands and utilities. A wealth of information is available from a variety of sources on Linux. Only the RTM3204-specific commands will be described in this chapter. The serial I/O port physical and electrical characteristics are defined as well.

General Linux Shell Operation

The RTM3204 is a derivative of our Tycho GPS Frequency Reference. As such, the user interface will refer to the Tycho GPS.

You do not need to know Linux in order to operate the RTM3204. However, for those interested, the command shell used by the RTM3204 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 RTM3204 you should consult good Linux reference books like:

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

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

Or the web at:

http://www.tldp.org

Available User Commands

COMMAND	FUNCTION
accessconfig	Interactive shell script that guides the user in configuring **`telnet, ssh`** and **`snmpd`** access to the RTM3204 that is limited to specific hosts. The resulting */etc/hosts.allow* and */etc/hosts.deny* files are saved to the non-volatile FLASH disk. Factory default configuration allows access by all hosts.
antfltmask	Prints the current setting for the Antenna Fault Mask.
cpuopts	Returns the current settings for any installed, user-selectable outputs from the CPU Module. These are 1PPS and time code (AM Code).
cpuoptsconfig	An interactive script that allows the user to modify the settings for the 1PPS and Time Code.
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 upgrade process.
gpscaldelay	Prints the calibration delay 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.
gsyshwaddr	Prints the ethernet hardware address, if the ethernet has been configured.
gsysosctype	Prints the installed oscillator type.
gsyspasswd	Allows the *root* user to change the password for the two configured users on the RTM3204: *gsysuser* and *root*. This script calls the standard Linux **`passwd`** binary and then saves the resulting */etc/shadow* file to the non-volatile FLASH disk.
gsysrootfs	Prints the current root file system image, either TychoGPS_0 (factory default) or TychoGPS_1 (field upgrade) which is running in the RTM3204/Tycho to the console.
gsystimemode	Prints the time mode settings in effect for the timecode or Serial Time output.
gsystimemodeconfig	Interactive shell script that guides the user in configuring the time mode settings for the timecode or Serial Time 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.
gsysversion	Prints the Linux Subsystem software version information to the console.
help	Prints help for RTM3204 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 RTM3204.
netconfig	Interactive shell script that allows the user to configure the IP network subsystem of the RTM3204.
oscctrlstat	Prints the oscillator disciplining parameters.
pluginopts	The RTM3204 is a derivative of a rackmount product - the Tycho GPS. This command will show that Slot 2 has a 10MPPS and a 1PPS Output. If the optional fixed rate output exists then it will also be shown.
setantfltmask	Command to enable or mask the Antenna Fault.
setgpscaldelay	An interactive script that allows the user to change the clock calibration delay.
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.
setsigfltmask	Command to mask or enable the Signal Loss Fault.
settfomfltlvl	Command to change the TFOM Fault Level.
sigfltmask	Prints the current setting for the Signal Loss Fault mask.
tfomfltlvl	Prints the current setting for the TFOM Fault Level.
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.
upgradekernel	Shell script that facilitates the Linux kernel firmware upgrade process. Limited applicability. Use with caution.

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 RTM3204/Tycho. 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-volatilely stored in the FLASH disk */boot/etc* directory. You must reboot the RTM3204/Tycho after running this script for the changes to take effect.

Set:	**accessconfig**
RTM3204/Tycho response:	Interactive shell script is started.

antfltmask

This command displays the current setting for the Antenna Fault Mask.

Query:	**antfltmask**
RTM3204/Tycho response:	**Antenna Fault is ENABLED**

cpuopts

This command displays the current settings for the 1PPS and time code (AM Code) outputs.

Query:	**cpuopts**
RTM3204/Tycho response:	**CPU Option 1PPS is installed.** **Current setting = 20 microseconds.** **CPU Option TIME CODE is installed.** **Current Setting = IRIG-B122.**

cpuoptsconfig

This command starts an interactive shell script that will allow the root user to change the settings of the 1PPS pulse width and the time code format.

Set:	**cpuoptsconfig**
RTM3204/Tycho response:	Interactive shell script is started.

eraserootfs_1

This command erases the UPGRADE root file system FLASH partition in preparation for performing a Linux Subsystem firmware upgrade. See ***Appendix B - Upgrading the Firmwar***e for more information.

Set:	**eraserootfs_1**
RTM3204/Tycho response:	Erase progress as percent is shown.

gpscaldelay

This command displays the current calibration delay setting. The allowable calibration delay range is +500000 to -500000 nanoseconds.

Query:	**gpscaldelay**
RTM3204/Tycho resposne:	**+0 nanoseconds**

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 RTM3204 is installed on a moving platform. When it is OFF, it is assumed that the RTM3204 is installed in a stationary location.

When the dynamic mode is OFF, the RTM3204 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**
RTM3204/Tycho response: **OFF**

The accuracy and stability specifications in ***Appendix I - Specifications*** assume a stationary platform and an antenna with a full view of the sky. Accuracy and stability performance will degrade in dynamic mode.

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.

Query: **gpsrefpos**
RTM3204/Tycho 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 Subsystem. During normal operation, a Linux daemon (SYSTIMED) polls the GPS Subsystem every eight 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 information contained therein and prints this fixed-length string having these fields:

```
LKSTAT TFOM = ? YEAR DOY HH:MM:SS.sssssssss LS LF S N VCDAC C/No FLTS
```

Where:

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

TFOM = ? A detailed explanation of TFOM is in ***Appendix A - Time Figure-of-Merit***.
Briefly, TFOM indicates clock accuracy where:

3	time error is < 100 ns
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 information received from the GPS Subsystem.

DOY is the day-of-year of the UTC timestamp of the most recent information received from the GPS Subsystem..

HH:MM:SS.sssssssss is the hour, minute, second.subsecond UTC timestamp of the most recent information received from the GPS Subsystem.

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 20-bit oscillator Voltage Control DAC word, 0 to 1048575 with larger numbers implying higher oscillator frequency. Typical range is 320000 to 640000.

C/No 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 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. Note: The value referred to here is the upper 16 bits of a 20-bit DAC value.

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 equal to the TFOM Fault Level (see the **`settfomfltlvl`** command). 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. 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 Subsystem is not receiving polling request from the Linux Subsystem (SYSTIMED daemon). 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 downlead cable has a fault. It indicates either an over or under current condition. Usually it means that the antenna downlead cable is not plugged into the connector on the rear of the RTM3204. If the condition persists after checking the antenna/downlead 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**
RTM3204/Tycho 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**
RTM3204/Tycho 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**
RTM3204/Tycho response: **F/W 1.00 FPGA 0202**

gsyshwaddr

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

Query:	**gsyshwaddr**
RTM3204/Tycho response:	**00:D0:C9:25:78:59**

gsysosctype

This command displays the installed oscillator type. It is one of TCXO, MS-OCXO, HS-OCXO or US-OCXO. The standard oscillator is the TCXO.

Query:	**gsysosctype**
RTM3204/Tycho response:	**Installed Oscillator is TCXO.**

gsyspasswd

This command allows the root user to change the passwords of the two configured users on the system: *root* and *gsysuser*. Arguments passed to **gsyspasswd** 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.

To change root password:

Set:	**gsyspasswd**
RTM3204/Tycho response:	The passwd interactive utility starts.

To change csysuser password:

Set:	**gsyspasswd csysuser**
RTM3204/Tycho response:	The passwd interactive utility starts.

gsysrootfs

This command displays the currently booted root file system image. It can be either TychoGPS_0 (factory image) or TychoGPS_1 (field upgrade image). Refer to ***Appendix B - Upgrading the Firmware*** for detailed instructions on performing the upgrade procedure.

Query:	**gsysrootfs**
RTM3204/Tycho response:	**BOOT_IMAGE=TychoGPS_1**

gsystimemode

This command displays the current time mode settings for any optional timecode or Serial Time Output. The time mode setting can be UTC, GPS or Local. The 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 time zone and that local time is ahead of UTC.

Query: **gsystimemode**
RTM3204/Tycho 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
```

gsystimemodeconfig

This command starts an interactive shell script that will allow the user to configure the time mode of any optional time code or Serial Time outputs. Selections are UTC, GPS or Local. *These settings have no effect on the operation of the underlying Linux operating system time. It ALWAYS operates in UTC.*

By default, the unit is configured to operate in UTC. If you need to modify this setting you must run this script as root. Settings made using this command are non-volatile.

Set: **gsystimemodeconfig**
RTM3204/Tycho response: Interactive shell script is started.

gsysversion

This command displays the firmware version and build date of the Linux Subsystem (root file system).

Query: **gsysversion**
RTM3204/Tycho response:
```
Tycho GPS 6010-0042-000 v 2.00 Wed Jan 16 22:38:21 UTC 2004
```

help

This command displays a list of the RTM3204/Tycho commands (not Linux commands). To get help on a particular command you would type **help**, followed by the command.

Query: **help**
RTM3204/Tycho response: RTM3204/Tycho commands are displayed.

Query: **help gpsstat**
RTM3204/Tycho 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 RTM3204/Tycho. Three protocol servers may be configured: TIME, DAYTIME, and TELNET. 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 reboot the RTM3204/Tycho after running this script for the changes to take effect.

Set:	**inetdconfig**
RTM3204/Tycho 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 RTM3204. 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 reboot the RTM3204/Tycho after running this script for the changes to take effect.

Set:	**netconfig**
RTM3204/Tycho response:	Interactive shell script is started.

oscctrlstat

This command displays the current settings for the oscillator control parameters. These parameters are used to discipline the oscillator. The command formats the data and prints this fixed-length string having these fields:

```
Oscctrlstat = LKSTAT COAST ESTERR MEASERR TIMEDEV AGERATE TAU DAC TEMP
```

Where:

LKSTAT	is the GPS Subsystem control status, either acquiring, locking or locked.
COAST	is the number of seconds in coast mode (unlocked).
ESTERR	is the estimated time error when in coast mode in seconds.
MEASERR	is the last measured time offset while locked in seconds.
TIMEDEV	is the time deviation (TDEV) of measurements in seconds.
AGERATE	is the regression computed oscillator ageing rate per day (several hour delay before the first measurements are displayed.).
TAU	is the oscillator control loop averaging time constant in seconds.
DAC	The oscillator control DAC value indicates the frequency control setting. The system automatically sets this value to remove frequency errors. Values may range from 0 to 1048575. Values close to the maximum/minimum will set the DAC fault flag that will appear in the fault status display. The Time/Status display will also indicate a fault condition.
TEMP	is the internal temperature in °C for OCXO and Rubidium oscillators only.

Query: **oscctrlstat**
RTM3204/Tycho response:

```
Oscctrlstat = LKD  0 2.72e-09 -2.72e-09 1.23e-09 -0.00e+00   235.2  524332 -999.999
```

pluginopts

This command displays the outputs for the installed "option" board. The RTM3204 is a derivative of a rackmount product - the Tycho. The response to this command will show five option slots available but in the RTM3204 only one is used - Slot 2.

Query: **pluginopts**
RTM3204/Tycho response:

```
Digital Outputs is Installed -- 2xTTL
Port A Current Setting = 10M PPS
Port B Current Setting = 5M PPS
Port C Current Setting = No Out
Port D Current Setting = No Out
```

setantfltmask

This command allows the user to enable or mask the GPS antenna fault. Parameter for this command is either MASKED or ENABLED. Setting this command to MASKED will prevent the antenna fault from creating an alarm condition. Some installations may need to mask this fault due to special antenna situations like splitters or DC blocks that confuse the antenna detection circuit. The factory default setting is ENABLED.

Set: **antfltmask MASKED**
RTM3204/Tycho response: **Antenna Fault Mask set to MASKED**

setgpscaldelay

This command starts an interactive shell script that allows the user to change the clock calibration delay. This setting is used to advance or retard the clock in order to compensate for antenna cable length or other external hardware. Allowable range is +500000 to -500000 nanoseconds.

Set: **setgpscaldelay**
RTM3204/Tycho 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 RTM3204 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-volatilely.

Set: **setgpsdynmode ON**
RTM3204/Tycho 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 RTM3204. By default, the unit is configured to locate itself using the GPS satel-

lites. 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. *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 RTM3204 to re-establish a new reference position using the GPS satellite constellation.

Set:	**setgpsrefpos**
RTM3204/Tycho response:	Interactive shell script is started.

setsigfltmask

This command allows the user to enable or mask the Signal Loss Fault. Parameter for this command is either MASKED or ENABLED. Setting this command to MASKED will prevent a signal loss fault from creating an alarm condition. The factory default setting is ENABLED.

Set:	**sigfltmask MASKED**
RTM3204/Tycho response:	**Signal Loss Fault Mask set to MASKED**

settfomfltlvl

This command allows the user to change the TFOM Fault Level. This is the threshold at which a signal loss fault will be asserted. See ***Appendix A - Time Figure of Merit*** for more information. By changing the TFOM Fault Level you control the point at which the time error will produce a signal loss fault, which then creates an alarm condition. The factory default setting is 9, which is the maximum TFOM value.

Set:	**settfomfltlvl 6**
RTM3204/Tycho response:	**TFOM Fault Level set to 6**

sigfltmask

This command displays the current setting for the Signal Loss Fault Mask.

Query:	**sigfltmask**
RTM3204/Tycho response:	**Signal Loss Fault is ENABLED**

tfomfltlvl

This command displays the current setting for the TFOM Fault Level.

Query:	**tfomfltlvl**
RTM3204/Tycho response:	**9**

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 RTM3204/Tycho 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**
RTM3204/Tycho response:	**UPGRADE is the default root file system.**
Query:	**updaterootflag 2**
RTM3204/Tycho 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**

RTM3204/Tycho 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 90 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
```

upgradekernel

This script allows the user to change the Linux kernel firmware. It requires one argument: the path to the file to be uploaded to the RTM3204/Tycho. Changing the Linux kernel firmware will enable IPv6 operation and should only be done if you have a requirement for IPv6. See ***Appendix F - IPv6 Information*** and ***Performing the Linux Kernel Upgrade*** in ***Appendix B - Upgrading the Firmware*** for more information.

Set	`upgradekernel /tmp/newkernelimage`
RTM3204/Tycho response:	Interactive shell script is started.

RS-232 Serial I/O Port Signal Definitions

The RS-232 DB9M connector on the rear panel of the Tycho is wired as shown below. In order to connect the Tycho 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 Tycho to your computer.

RTM3204 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

Chapter *Four*

HTTP Interface

This chapter briefly describes the HTTP interface that resides on the RTM3204 GPS Timing Module. The HTTP interface to the RTM3204 is a fast and easy-to-use graphical interface that is compliant with your standard web browser. Simply point your browser to the IP address of the RTM3204 and login securely with HTTP. Security-conscious customers may disable the HTTP interface (see the end of this Appendix Hor instructions). Note: The HTTP interface is not IPv6-compliant.

Note: The RTM3204 is a derivative of our standard product, the Tycho GPS Frequency Reference. As such, the software interface will contain references to Tycho GPS.

The HTTP interface is not available in older RTM3204/Tycho models. The older models have a Linux Subsystem root file system (RFS) number of 6010-0042-000. To see the number enter the **`gsysversion`** command via the network/serial port. The newer RTM3204/Tycho models have (or can have) the HTTP interface capability. These models have a Linux Subsystem RFS number of 6010-0044-000.

The HTTP implementation in the RTM3204/Tycho uses HTTPS (HTTP over SSL). Secure Socket Layer (SSL) is a sublayer under regular HTTP. HTTPS enhances security because it encrypts and decrypts the requested and returned pages from the server.

The HTTP implementation is built from the standard Apache/1.3.33 distribution from:

http://httpd.apache.org

See ***Appendix D - Security*** for information on changing the default HTTP configuration and SSL certificates.

IMPORTANT

The domain name server IP address is required by the Apache web server. When using **`netconfig`** (see ***Chapter 3 - Control and Status Commands***) to configure the TCP/IP parameters be sure to configure the name server. Only one name server is required, two gives some redundancy. The HTTP Interface will not start if this is configured incorrectly.

HTTP Interface Description

For security reasons the web pages on the RTM3204/Tycho show status information only. You cannot reconfigure the RTM3204/Tycho except for upgrading firmware, which is done with several security measures in place. To reconfigure the RTM3204/Tycho you will need to use the network or serial port command line interface.

NOTE

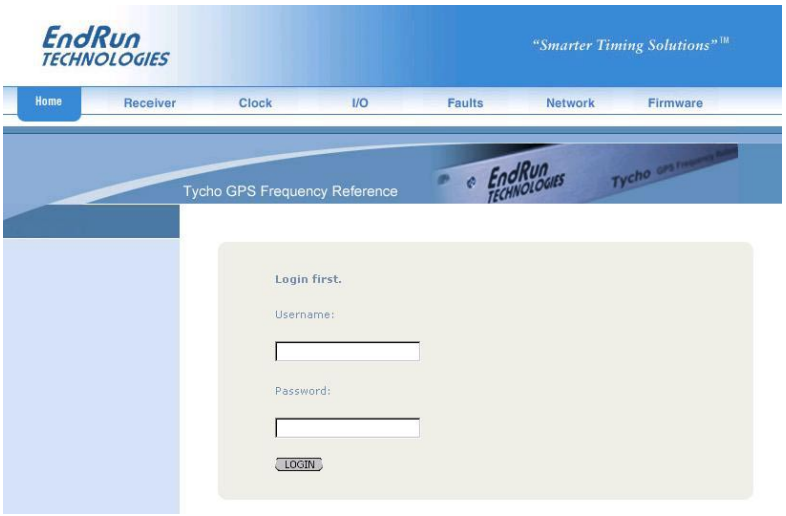
For proper operation, your web browser must be configured to allow pop-up windows and have Javascript enabled.

To get started with the web interface simply point your browser to the IP address of the Tycho and log in securely with HTTP. For example:

http://192.168.1.1

A warning dialog page will be presented for the certificate. Acknowledge the dialog page and the server will continue to load, protected by SSL. The browser should display the "Lock" icon, indicating that the page is protected by SSL. To maximize security you should replace the SSL Certificate. See ***Appendix D - Security, HTTP*** for details.

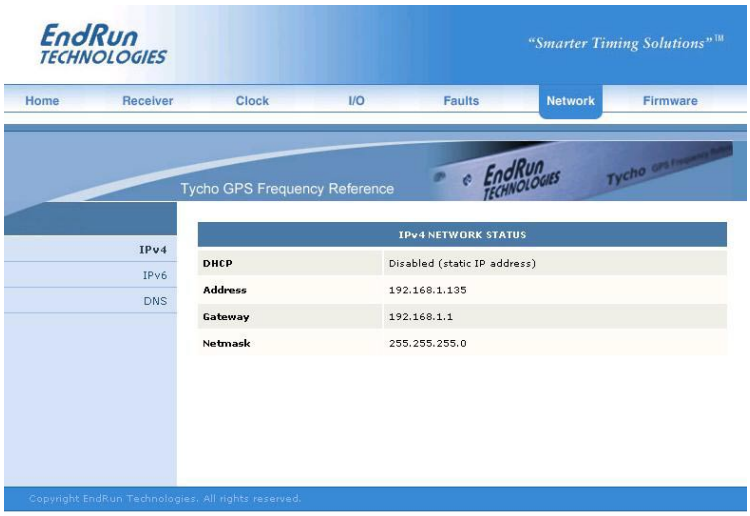
Below is a picture of the login page:



Navigation

The main menu tabs across the top of each webpage allow you to navigate through the status information in the RTM3204/Tycho while links on the lefthand side of each webpage provide subcategory navigation.

For example, in the page below the main menu tabs are: Home, Receiver, Clock, I/O, Faults, Network, and Firmware. The subcategory links on this particular page are: IPv4, IPv6 and DNS. IPv4 is selected.



The top-hand tabs and left-side links are logically arranged for easy navigation. The following table defines this relationship:

Tab	Information	Links
Home	Overall RTM3204/Tycho Status Information	Login, Logout
Receiver	GPS Receiver Status	Receiver, Oscillator
Clock	Clock Status	
I/O	I/O Status (Option)	CPU Options, Plug-In Options
Faults	Fault Status	
Network	IPv4 Network Status	IPv4, IPv6, DNS
Firmware	Firmware Information	Firmware Status, Linux Subsystem Upgrade, GPS Subsystem Upgrade, Reboot

Page Descriptions

Home Page

This page contains general status information. Data fields are:

UTC Time

Shows the current hours, minutes and seconds in UTC.

Date

Shows the current UTC date.

Receiver

Shows whether the GPS receiver is locked or not.

TFOM
Shows the current TFOM value. See ***Appendix A - Time Figure of Merit*** for more information.

System Status
Shows if any system fault is present. If a system fault exists, go to the Faults Page to see which fault it is.

Receiver Page

This page contains information related to the GPS Receiver. Data fields are:

State
Shows whether the GPS receiver is locked or not.

TFOM
Shows the current TFOM value. See ***Appendix A - Time Figure of Merit*** for more information.

Satellite ID
This field lists the satellites that are currently being tracked. Up to 8 may be tracked at a time.

Average C/No
The carrier-to-noise ratio is an indicator of the GPS signal quality. This number typically ranges from 30 to 45 dB when the Meridian is locked.

GPS Dynamic Mode
This field shows whether the dynamic mode is set or not. Dynamic mode should be OFF when the Meridian is in a static (not moving) position. To change the dynamic mode setting use the **`gpsdyn-mode`** command.

Reference Position Source
The source of the reference position can be Unknown, Dynamic, User-Entered or Average (24-hour average of GPS fixes). To change the reference position source use the **`gpsrefpos`** command.

Reference Position Latitute, Longitude and WGS-84 Height
The WGS-84 latitude and longitude in degrees, minutes, seconds format and the height above the WGS-84 reference ellipsoid in meters is shown.

Last Position Fix Latitute, Longitude and WGS-84 Height
This field shows information for the most recent position fix. The WGS-84 latitude and longitude in degrees, minutes, seconds format and the height above the WGS-84 reference ellipsoid in meters is shown.

Antenna Fault Mask
This field shows the current setting for the Antenna Fault Mask. When the antenna fault is masked this will prevent the antenna fault from creating an alarm condition. Some installations may need to mask this fault due to special antenna situations like splitters. To change the Antenna Fault Mask use the **`setantfltmask`** command.

Signal Fault Mask
This field shows the current setting for the Signal Alarm Mask. When the signal alarm is masked it

will prevent a signal loss fault from creating an alarm condition. To change the signal alarm mask use the **`setsigfltmask`** command.

TFOM Fault Level
This field shows the threshold at which a signal loss fault will be asserted. See ***Appendix A - Time Figure of Merit*** for more information. You can change the TFOM Fault Level by using command **`settfomfltlvl`**. By changing the TFOM Fault Level you control the point at which the time error will produce a signal loss fault, which then creates an alarm condition. The factory default setting is 9.

Clock Calibration
This field shows the clock calibration delay which is used to advance or retard the clock in order to compensate for antenna cable length or other external hardware. Use the **`setGPScaldelay`** command to change this setting.

Receiver (Oscillator) Page

This page shows receiver oscillator control information such as:

Oscillator Type
This field shows the oscillator type that is installed in the RTM3204/Tycho. It will be either a TCXO or a Rubidium. The standard oscillator is the TCXO.

DAC
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.

Measured Time Error
The measured time error is the last measured time offset while locked.

Time Deviation
This field shows the time deviation (TDEV) of measurements.

Oscillator Ageing Rate
This field shows the regression computed oscillator ageing rate per day. There is a several-hour delay before the first measurement is shown.

Control Loop TAU
This is the oscillator control loop averaging time constant.

Coast Duration
The coast duration is the number of seconds in coast mode (unlocked).

Estimated Time Error
This field shows the estimated time error when in coast mode.

Internal Chassis Temperature
This field shows the internal temperature in °C.

Clock Page

This page shows the configuration of the RTM3204/Tycho except for any optional I/O which is listed on the I/O page. Fields are:

Time Mode

This field shows the current time mode setting. Possible settings are UTC, GPS and LOCAL. This setting affects the Time Code Output. To change the time mode setting use the **`gsystimemodeconfig`** command via the network/serial port.

Local Time Offset

This field shows the offset from UTC and is only valid when the Time Mode is LOCAL. A positive Local Time Offset implies a longitude east of the Greenwich meridian. To change the local offset use the **`gsystimemodeconfig`** command.

Daylight Savings Time (DST), DST Start, DST End

The DST fields show whether DST is enabled and if so, what the DST Start and Stop Times are. For example, in most of the U.S.A. the DST Start Time is the 2nd Sunday in March at 2 a.m. The DST End Time is the 1st Sunday in November at 2 a.m. To change the DST settings use the **`gsystimemodeconfig`** command.

I/O Page (CPU Options)

A basic RTM3204 has two options installed - a 1PPS and time code (AM Code). This page shows the settings for the 1PPS pulse width and the time code format. Use commands **`cpuoptsconfig`** to change these settings.

I/O Page (Plug-In Options)

This page shows the installed 1PPS, 10MPPS and any optional Fixed Rate Output.

Faults Page

This page lists all possible fault conditions of the GPS Subsystem. The various faults are described below:

FLASH

This fault 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. The unit should be returned to the factory for repair.

FPGA

This fault 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 .

Signal

This fault 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.

DAC
This fault 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 your convenience.

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

Polling Events
This fault indicates that the GPS Subsystem is not receiving polling request from the Linux 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.

Time Reference
This fault 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).

Network Page
This page shows the IPv4 network configuration. Fields are:

DHCP
By default, the RTM3204/Tycho will configure itself using the Dynamic Host Configuration Protocol (DHCP). If you need to set up static IP configuration, you must use the **`netconfig`** command via the network/serial port. Thie field will show whether DHCP is enabled or disabled.

Address, Gateway, Netmask
These fields show the settings for the IP address, gateway and netmask. To change these settings use the **`netconfig`** command via the network/serial port.

Network (IPv6) Page
This page shows information related to the IPv6 network parameters. If your RTM3204/Tycho does not have IPv6 then there will be no fields on this page. For more information on IPv6 see ***Appendix F - IPv6 Information***.

Network (DNS) Page
This page shows the IP address of the primary and secondary domain name servers.

Firmware Page

The firmware status page shows part numbers and versions of the Linux Subsystem firmware (root file system and kernel) and the GPS Subsystem firmware.

Linux Subsystem Upgrade, GPS Subsystem Upgrade

These pages are used for upgrading the firmware. You must be logged in as "root" in order to have access to these pages. The latest released versions of RTM3204/Tycho firmware are freely available on the EndRun website. For detailed information on how to perform the upgrade either via the network port, the serial port, or the HTTP interface see ***Appendix B - Upgrading The Firmware***. Only the Linux Subsystem root file system (RFS) and GPS Subsystem can be upgraded via the HTTP interface. To upgrade the Linux Subsystem kernel see ***Appendix B - Upgrading the Firmware, Performing the Linux Kernel Upgrade***.

Reboot

This page will allow you to perform a software reboot of both the Linux Subsystem and the GPS Subsystem. This is normally used after a firmware upgrade but can be done anytime you wish to reset the RTM3204/Tycho.

Disabling The HTTP Protocol

To disable HTTP you need to edit a system start-up script called */etc/rc.d/rc.local*. This script starts several daemons. You can either remove the line that lists HTTP or you can 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 reboot 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.

Appendix *A*

Time Figure-of-Merit (TFOM)

This appendix describes the Time Figure of Merit (TFOM) number. The RTM3204 displays this number in the time-of-day fields printed by the **`gpsstat`** *command (see Chapter 3). 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 RTM3204 reports this value as accurately as possible, even during periods of GPS signal outage where the RTM3204 is unable to directly measure the relationship of its timing outputs to UTC. During these GPS outage periods, assuming that the RTM3204 had been synchronized prior to the outage, the RTM3204 extrapolates the expected drift of the RTM3204 timing signals based on its knowledge of the characteristics of the internal Temperature Compensated Crystal Oscillator (TCXO) 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.

During periods of signal loss, the GPS Subsystem will compute an extrapolated worst case time error as described above. If the signal loss condition persists you will see the TFOM character change to indicate a gradually deteriorating accuracy of the timing outputs. One hour after the worst case time error has reached the value equivalent to a TFOM of TFOM Fault Level, the red LED will illuminate. The fault status field returned in the **`gpsstat`** command will have the appropriate bit set to indicate a loss-of-signal time-out condition.

You may control the TFOM level at which a loss-of-signal alarm is generated by changing the TFOM Fault Level. This can be done through the console port (see the **`settfomfltlvl`** and **`tfomfltlvl`** commands in ***Chapter 3 - Control and Status Commands***). The factory default setting for the TFOM Fault Level is 9.

The TFOM Fault Level setting only affects the point at which the loss-of-signal alarm is asserted.

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.

The RTM3204 is a derivative of our standard product - the Tycho GPS Frequency Reference. So when upgrading software, please use the software for the Tycho GPS. You may securely upgrade your Tycho firmware via the HTTP interface, the network port, or the serial port. Software upgrades for the RTM3204/Tycho are available at this link:

http://www.endruntechnologies.com/upgradetyc.htm

Upgrade Via The HTTP Interface

The HTTP interface is not available in the older RTM3204/Tycho models. These models have a Linux Subsystem root file system (RFS) number of 6010-0042-000. To see the number enter the **`gsysversion`** command via the network/serial port. If you have one of the older RTM3204/Tycho models please proceed to the next section - ***Upgrade Via The Network/Serial Port***.

The newer RTM3204/Tycho models have (or can have) the HTTP interface capability. These models have a Linux Subsystem RFS number of 6010-0044-000. The HTTP interface was introduced at version 5.50 of the Linux Subsystem software. If you have one of the newer RTM3204/Tycho models and your current software version is at least 5.50, you may upgrade firmware via the web interface or the network/serial port.

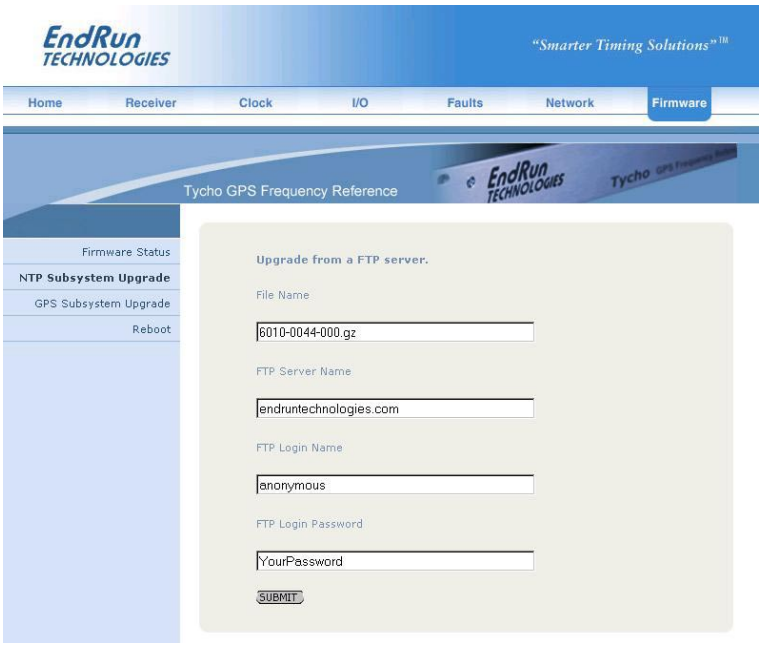
Software upgrades via the HTTP interface are simple, with your choice of two methods:

1. If your RTM3204/Tycho has access to the internet, the HTTP interface can automatically retrieve the appropriate files from the FTP server at endruntechnologies.com to temporary locations on the RTM3204/Tycho. You will need to authenticate the root user name and password, and follow the prompts from the HTTP interface to complete each upgrade, one for the Linux Subsystem and the other for the GPS Subsystem.

IMPORTANT

The domain name server IP address is required by the Apache web server. When using **`netconfig`** (see ***Chapter 3 - Control and Status Commands***) to configure the TCP/IP parameters be sure to configure the name server. Only one name server is required, two gives some redundancy. The HTTP Interface will not start if this is configured incorrectly.

The following picture shows the Linux Subsystem RFS Upgrade page. All fields are filled in with default values to download the appropriate software image from the EndRun Technologies website. You can use these default values unless you want to point to a different FTP server.



2. If your RTM3204/Tycho does not have access to the internet, you must first download the appropriate files from the endruntechnologies.com website to the computer that you will be using later to access the RTM3204/Tycho via its HTTP interface. Use the link shown above to get the files. After saving the files, use the RTM3204/Tycho HTTP interface to select the previously saved files for upload to the RTM3204/Tycho. One for the Linux Subsystem and the other for the GPS Subsystem. Then follow the remaining prompts from the HTTP interface to complete the upgrades. (You will need to authenticate the root user name and password.)

Upgrade Via The Network/Serial Port

In order to upgrade via the network or serial ports you will need to first download the appropriate FLASH binary image file from the EndRun website. After you have done this you are ready to upgrade your RTM3204/Tycho. The firmware consists of two FLASH binary image files. One of these is the firmware for the RTM3204/Tycho Linux Subsystem. This firmware executes on the IBM-compatible CPU and contains the embedded Linux operating system and application software. The other file is the firmware for the GPS Subsystem. Each of these files may be upgraded independently, although some upgrades require both images to be modified together.

You will need to use **ftp** or **scp** to transfer the binary image file(s) to the RTM3204/Tycho. This means that you must place the previously downloaded file(s) in a place on your network which is accessible to the RTM3204/Tycho.

Performing the Linux Subsystem 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 file when downloading from the website. Please make sure that the downloaded file size matches what the website says it should be. Upgrading the partition with a too-large file size will cause problems.

To perform the upgrade, log in as the *root* user to the RTM3204/Tycho 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 RTM3204/Tycho using FTP. The root file system image will be named with the software part number and version like: *6010-004x-000_3.00.gz*. When following the instructions below, substitute the name of the actual root file system image that you are installing for *6010-004x-000_3.00.gz*. Issue these commands from the console of your RTM3204/Tycho:

```
ftp remote_host                          {perform ftp login on remote host}
bin                                      {set transfer mode to binary}
get 6010-004x-000_3.00.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 RTM3204/Tycho. A command like this should be used:

```
scp -p 6010-004x-000_3.00.gz root@gsys.your.domain:/dev/rootfs_1
```

Update the default file system partition by issuing this command on your RTM3204/Tycho.

```
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 90 seconds for the system to shutdown and reboot. Then log in to the RTM3204/Tycho 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

```
gsysversion
```

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:

```
gsysrootfs
```

Which should cause this to be printed to the console:

```
BOOT_IMAGE=TychoGPS_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 90 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 RTM3204/Tycho.

Recovering from a Failed Upgrade

To restore your RTM3204/Tycho to a bootable state using the factory root file system, you must use the serial I/O port and reboot the RTM3204/Tycho 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 RTM3204/Tycho.

Pay close attention to the terminal window while the unit is rebooting. 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 Linux Kernel Upgrade

The RTM3204/Tycho is shipped from the factory with a kernel that is IPv4-only capable only. If you want to upgrade your kernel to the IPv4/IPv6-capable one then you must first be sure that your root file system is version 2.60 or later. To see the root file system version type **`gsysversion`** at the network/serial port.

To upgrade your kernel, log in as the *root* user to the RTM3204/Tycho using the local console serial I/O port, **`telnet`** or **`ssh`** and perform these operations:

If you are using **`ftp`** to perform the upgrade, transfer the previously downloaded file using *binary* transfer mode from the remote host to a temporary location on your RTM3204/Tycho using FTP. The IPv6 kernel image will be named with the software part number like: *6010-0041-100.bzimage*. When following the instructions below, substitute the name of the actual kernel image that you are installing for *6010-0041-100.bzimage*. Issue these commands from the console of your RTM3204/Tycho:

```
ftp remote_host                          {perform ftp login on remote host}
bin                                      {set transfer mode to binary}
get 6010-0041-100.bzimage /tmp           {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 RTM3204/Tycho. A command like this should be used:

```
scp -p 6010-0041-100.bzimage root@gsys.your.domain:/tmp
```

The kernel upgrade utility is executed with a single argument passed on the command line: the path to the previously uploaded kernel image file. For example:

```
upgradekernel /tmp/6010-0041-100.bzimage
```

The kernel upgrade utility verifies the integrity of the file, reads the kernel version information, presents it to you and asks you to verify before replacing the old kernel image. If you verify, it will then erase the old image and write the new one in its place. The erase and write operation takes about 10 seconds.

CAUTION

A power failure during the kernel erase and write operation would render your unit unbootable. It is highly advisable to plug your unit into a UPS while performing the kernel upgrade.

Performing the GPS Subsystem Upgrade

To perform this upgrade, log in as the *root* user to the RTM3204/Tycho 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*. The GPS Subsystem image will be named with the software part number and version like: *6010-0020-000_3.01.bin*. When following the instructions below, substitute the name of the actual GPS Subsystem image that you are installing for *6010-0020-000_3.01.bin*:

```
ftp remote_host                 {perform ftp login on remote host}
bin                             {set transfer mode to binary}
get 6010-0020-000_3.01.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 6010-0020-000_3.01.bin root@gsys.your.domain:/tmp
```

Now issue the following command to the RTM3204/Tycho console to initiate the upload:

```
upgradegps /tmp/6010-0020-000_3.01.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 90 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 RTM3204/Tycho 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 Subsystem 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 wating for a download. You may now retry 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/6010-0020-000_3.01.bin
```

Recover Command

Sometimes a user will attempt to download the wrong file to the GPS Subsystem. When this happens the recovery method above will not work. After issuing the **cat** command above you will not see a series of "C" characters, but instead you will see the bootloader message being output every few seconds. In this case you need to use a different recovery procedure.

First make sure the above **cat** command is killed by typing CTRL-C. Then enter a new **cat** command as:

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

You should again be seeing the bootloader message every few seconds:

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

Please type the following command but do not press enter:

```
echo -e "recover\r" > /dev/arm_user
```

Now wait until you see another bootloader message come out and then press enter. You will then see the "C" come out every 3 seconds. You then kill the previous **cat** command by entering:

```
kill $!
```

You should see a command prompt. Now issue this command to re-transfer the correct binary file:

```
upgradegps /tmp/6010-0020-000_3.01.bin
```

Appendix C

Simple Network Management Protocol (SNMP)

Your RTM3204 includes the (NET)-SNMP version 5.3.1 implementation of an 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 NET-SNMP project has its roots in the Carnegie-Mellon University SNMP implementation. For more detailed information about the NET-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 NET-SNMP implementations, is available from O'Reilley & Associates:

Essential SNMP, Mauro & Schmidt, O'Reilley & 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.

Note: The RTM3204 is derivative of the Tycho GPS Frequency Reference. As such, the software interface will contain references to Tycho GPS.

TYCHO-MIB

Which is located on your RTM3204/Tycho in this ASCII file:

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

In addition to a complete set of GPS status objects, the MIB defines two SMIv2 notification objects:

- 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 -m "MIBNAME" -Ls -d -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 reboot 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 TYCHO-MIB file on your SNMP management system and access the variables defined therein. The factory default community names are "TychoGPS" 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.

Change Default Community Strings (Passwords)

To ensure security, you should change the default community names by editing */etc/snmpd.conf* and modifying these two lines:

```
rwcommunity   endrun_1
rocommunity  TychoGPS
```

Configuring SNMPv1 Trap Generation

To have your RTM3204/Tycho 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 RTM3204/Tycho. 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 RTM3204/Tycho will only send a trap to the last declared **trapsink** in the file.

Configuring SNMPv2c Notifications and Informs

To have your RTM3204/Tycho 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 RTM3204/Tycho. 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 RTM3204/Tycho 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 reboot 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 (NET-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 RTM3204/Tycho via v3 of SNMP, you will have to configure two files:

/etc/snmpd.conf
/boot/net-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 RTM3204/Tycho, 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 tychouser 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 *tychouser* 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).endRunTechnologiesMIB(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/net-snmp/snmpd.conf* like these for each user:

```
createUser root    MD5 endrun_1 DES endrun_1
createUser tychouser SHA TychoGPS
```

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 *tychouser* to be created who may be authenticated using the Secure Hash Algorithm (SHA) with password *TychoGPS_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/net-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 rebooting, the agent will read the */boot/net-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

To generate new keys, stop the **snmpd** process, delete the existing **usmUser** key lines from the file ***/boot/net-snmp/snmpd.conf*** and then add new **createUser** lines. Then reboot 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.

Disabling The SNMP Protocol

To disable SNMP you need to edit a system start-up script called */etc/rc.d/rc.local*. This script starts several daemons. You can either remove the line that lists SNMP or you can place a **#** character at the beginning of the line so that it will not be executed. (A very compact editor is available on the Unison system called **edit**. If you start **edit** without giving it a file name to open, it will display its help screen, showing all supported editing keystrokes.)

IMPORTANT

After editing ***/etc/rc.d/rc.local***, you must copy it to the ***/boot/etc/rc.d*** directory and reboot 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.

Appendix *D*

Security

Your RTM3204 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 RTM3204. Others are provided by the additional protocol servers selected for inclusion in your RTM3204, 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`**. *Secure monitoring via web browser is provided by the Apache implementation of the Hyper Text Transport Protocol (HTTP) with Secure Sockets Layer (SSL) daemon, (***`httpd`***). The NET-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.*

IMPORTANT

SSH, Telnet, SNMP and HTTP are all enabled with default passwords. To ensure security, change the passwords or disable the protocols. To change the passwords for SSH, Telnet and HTTP use the **`gsyspasswd`** command. To change the passwords/community strings for SNMP see ***Appendix C - SNMP***.

By default all users are allowed access via SSH, Telnet and SNMP. To restrict access via these protocols, use the **`accessconfig`** command or edit /etc/hosts.allow and /etc/hosts.deny. All users are allowed access via HTTP as well. To restrict access via HTTP, edit /etc/apache/httpd.conf to set up access by specific hosts.

To completely disable any or all of these protocols see ***Disabling Protocols*** below.

Linux Operating System

Note: The RTM3204 is a derivative of our standard product, the Tycho GPS Frequency Reference. As such, the operating system software will refer to Tycho.

The embedded Linux operating system running in the RTM3204/Tycho is based on kernel version 2.4.31 and version 10 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 RTM3204/Tycho.

- HTTP may be completely disabled by configuration of */etc/rc.d/rc.local*.

- 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 directives contained in the files */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 RTM3204/Tycho by a pair of shell scripts which ease configuration for the inexperienced user of Unix-like operating systems. These are **accessconfig** and **inetdconfig**.

Using Edit

A very compact editor with WordStar command keystrokes is available on the system for editing files: **edit**. If you start **edit** without giving it a file name to open, it will display its help screen, showing all supported keystrokes.

Limiting Access

By default, the unit is configured to allow access by all users via Telnet, SSH and SNMP. To ensure security you should restrict access by using the **accessconfig** command.

accessconfig modifies two files which are used by **tcpd** and the standalone daemons, **snmpd** and **sshd**, 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 RTM3204/Tycho 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** and **sshd** daemons also parse this file 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.l68.1.3

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 capabilites 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. (See ***Using Edit*** above.) Be careful to maintain the proper ownership and access permissions by using **`cp -p`** when copying the files.

To control access via HTTP, the user must edit the */etc/apache/httpd.conf* file and add the equivalent deny followed by allow directives. For example, the default file contains these lines:

```
# Controls who can get stuff from this server.
#
    Order allow,deny
    Allow from all
</Directory>
```

To restrict access to a specific host with IP address xxx.xxx.xxx.xxx, you would modify the directives as so:

```
# Controls who can get stuff from this server.
#
    Order allow,deny
    Deny from all
    Allow from xxx.xxx.xxx.xxx
</Directory>
```

Disabling Protocols

You may completely disable any of the following protocols: Telnet, TIME, DAYTIME, SSH, SNMP and HTTP.

Disable Telnet, TIME and DAYTIME

To disable Telnet, TIME and DAYTIME use the **`inetdconfig`** command. **`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, three servers are configurable via **`inetdconfig`**: TIME and DAYTIME, whose daemons are contained within the **`inetd`** daemon itself, and **`in.telnetd`**. Any one or all of these may be enabled or disabled for start-up.

Disable SNMP and HTTP

To disable SNMP and HTTP, edit a system start-up script called */etc/rc.d/rc.local*. This script starts several of the daemons running on the system. You should follow the instructions contained in comments in the file for disabling the **`snmpd`** and **`httpd`** daemons. Placing a **`#`** character at the beginning of a line makes it a comment line so that it will not be executed. (See ***Using Edit*** above.)

Disable SSH

To disable SSH, edit a system start-up script called */etc/rc.d/rc.inet2*. This script starts several of the daemons running on the system. You should follow the instructions contained in comments in the file for disabling the **sshd** daemon. Placing a **#** character at the beginning of a line makes it a comment line so that it will not be executed. (See ***Using Edit*** above.)

IMPORTANT

After editing ***/etc/rc.d/rc.local and/or /etc/rc.d/rc.inet2***, you must copy them to the ***/boot/etc/rc.d*** directory and reboot the system. It is very important to retain the access mode for these files, 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.

OpenSSH

The secure shell protocol server running in the RTM3204/Tycho is based on the portable OpenSSH for Linux. As such it supports both SSH1 and SSH2 protocol versions. By default, only SSH2 is enabled due to security issues with SSH1. 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'Reilley & Associates:

SSH, The Secure Shell, Barrett & Silverman, O'Reilley & 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 RTM3204/Tycho. This means that users on remote hosts may log in to the RTM3204/Tycho via an **ssh** client, but users logged in on the RTM3204/Tycho 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 RTM3204/Tycho via **scp** over **ssh** but users logged in on the RTM3204/Tycho 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 RTM3204/Tycho 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 RTM3204/Tycho. Three files contain these keys: *identity* (SSH1), *id_rsa* (SSH2) and *id_dsa* (SSH2). These must be copied to the user's *root/.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 RTM3204/Tycho. 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 RTM3204/Tycho. At boot time, the RTM3204/Tycho 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 RTM3204/Tycho. 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.

To disable the SSH protocol, see ***Disable SSH*** above.

HTTP

The HTTP server in the RTM3204/Tycho is built from the standard Apache/1.3.33 distribution from:

http:/httpd.apache.org

It uses HTTPS (HTTP over SSL) with mod_ssl (the Apache interface to OpenSSL). For more information about this protocol, refer to http:/www.modssl.org.

HTTP and SSL use two files for the default configuration located in */etc/apache*. These are *httpd.conf* and *ssl.conf*. Advanced users who need to modify the default configuration will need to edit these two files and copy them to the */boot/etc/apache* directory. (See ***Using Edit*** above.)

For SSL it is recommended that new certificates are generated and installed on the Apache web server with mod_ssl. The current certificates included are located in */etc/apache/ssl.ctr*, */etc/apache/ssl.csr*, and */etc/apache/ssl.key*. New certificates, CSRs, and private keys will need to be saved in */boot/etc/apache/ssl.crt*, */boot/etc/apache/ssl.csr*, and */boot/etc/apache/ssl.key* directories.

By default, the Apache server configuration file httpd.conf for httpd is factory-configured. It contains the configuration directives that give the server its instructions. Although not required, the directives may be changed by editing */etc/apache/httpd.conf*, and then copying it to */boot/etc/apache*. Do not attempt to change the directives unless you have a real need to do so.

An excellent book which describes operation and configuration of the various HTTP directives and SSL configuration is:

Professional Apache, Wainwright, Wrox Press, 1999.

To disable HTTP, see ***Disable SNMP and HTTP*** above.

Appendix *E*

Timecode Formats

A standard feature of your RTM3204 GPS Timing Module is a single timecode output available at the rear panel SMB connector identified as AM CODE A DC-shift time code output is available via the optional Programmable TTL Output.

The output code format is selectable via a console command. See **`cpuopts`** *in* ***Chapter 3 - Control and Status Commands****. Each format is described below. Time codes are commonly used to provide time information to external devices such as displays, magnetic tape devices, strip chart recorders and several types of embedded computer peripheral cards.*

IRIG-B122

This is the most widely used format and is normally the factory default for the AM Code output. The IRIG-B122 format is a 100 pps code and is used to amplitude modulate a 1000 kHz sine wave carrier. The information contained in the timecode is seconds through day-of-year coded in Binary Coded Decimal (BCD). Reference IRIG Document 104-60.

IRIG-B123

In addition to the time information identified in B122 above, this format also contains Straight Binary Seconds (SBS) of day. SBS is provided at the end of the frame, in the 17 bits starting in position 80.

IEEE-Standard 1344-1995

This standard provides for the addition of time/status data in the control bit positions of IRIG-B. The information provided there is: Unit and Tens of Years, Leap Second, Daylight Savings, Local Time Offset, Time Quality and Parity. The IEEE-1344 table provided below shows each bit position with detailed information.

NASA-36 Bit

NASA-36 bit time code is a 100-bit, pulse width modulated format used to amplitude modulate a 1000 kHz sine wave carrier. The information contained in the timecode is seconds, minutes, hours and days. The format is used by several military ranges. Reference IRIG Document 104-59.

2137

The 2137 code is a 25-bit pulse width modulated format used to amplitude modulate a 1000 kHz sine wave carrier. The information contained in the timecode is seconds, minutes and hours. The format is used by certain security organizations.

IEEE-1344 Bit Definition

Bit Position	Bit Definition	Explanation
P50	Year, BCD1	Unit years
P51	Year, BCD2	
P52	Year, BCD4	
P53	Year, BCD8	
P54	Not used	
P55	Year, BCD10	Tens years
P56	Year, BCD20	
P57	Year, BCD40	
P58	Year, BCD80	
P59	P6	Position identifier
P60	Leap second pending	Set to one, 59 seconds prior to leap insertion
P61	Leap second	0 = add second, 1 = delete second
P62	Daylight Savings Time pending	Set to one, 1 second prior to DST change
P63	Daylight Savings Time	1 = DST active
P64	Local offset sign	0 = +, 1 = -
P65	Local offset binary 1	Local offset from UTC time
P66	Local offset binary 2	
P67	Local offset binary 4	
P68	Local offset binary 8	
P69	P7	Position identifier
P70	Local offset half hour bit	0 = none, 1 = half hour time offset added
P71	Time quality binary 1	Time quality indicates clock precision.*
P72	Time quality binary 2	
P73	Time quality binary 4	
P74	Time quality binary 8	
P75	Parity	Odd parity for all preceding data bits
P76-P78	Not used	
P79	P8	Position identifier

* Refer to Appendix A - Time Figure-of-Merit for detailed information. Briefly:

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.

Appendix *F*

IPv6 Information

EndRun Technologies understands that IPv6 is still in the experimental stage with essentially no mainstream deployment. Customers who are not interested in IPv6 need not burden your system with it. You have a choice of an IPv4-only kernel (recommended) or the IPv4/IPv6-kernel. You may freely change this at any time with an easy software download from our website.

To determine which kernel resides in your RTM3204/Tycho check the firmware version using console port command **`cat /proc/version`**.

An IPv4-only kernel will have a part number and version similar to:

6010-0041-000 ver 2.4.31-IPv4

An IPv4/IPv6 kernel will have a part number and version similar to:

6010-0041-100 ver 2.4.31-IPv6

If you want to change your kernel please refer to ***Appendix B - Upgrading The Firmware*** for instructions. The following text refers to products with the IPv4/IPv6 kernel.

Enabling New IPv6 Capabilities

The presence of an IPv6-capable kernel will automatically enable most of the new IPv6 capabilities. By default, autoconfiguration of the ethernet interface via IPv6 Router Advertisements is enabled. To disable acceptance of Router Advertisements, or to configure a static IPv6 address and default IPv6 gateway, you must run the interactive **`netconfig`** script. This will allow you to configure your ethernet interface for both IPv4 and IPv6 operation. Using the **`netconfig`** script has the advantage that you can also configure the hostname and domainname for the unit, and any nameservers you may want it to have access to.

OpenSSH

By default, **`sshd`** is factory-configured to listen on both IPv4 and IPv6 addresses. It may be forced to listen on either IPv4 only, or IPv6 only by editing the */etc/rc.d/rc.inet2* startup script, where **`sshd`** is started, and then copying it to */boot/etc/rc.d*.

Net-SNMP

By default, **`snmpd`** is factory configured to listen on both IPv4 and IPv6 addresses. This may be changed by editing */etc/rc.d/rc.local* and modifying the agent address argument passed to **`snmpd`** at start-up, and then copying it to */boot/etc/rc.d*.

IPv6-Capable syslog-ng

To enable remote syslogging to an IPv6 host, you will need to edit the new */etc/syslog-ng.conf* file and copy it to */boot/etc*. At boot time, the presence of both the **`syslog-ng`** daemon and the *boot/etc/syslog-ng.conf* file will cause the new IPv6-capable **`syslog-ng`** daemon to be started instead of the previous **`syslogd/klogd`** pair of daemons. These two files remain on the system for backward compatibility with customers' existing */etc/syslog.conf* setups, but they are not IPv6 capable. If you are not currently directing your system logs to a remote host, or you are not using IPv6, then there is little need or benefit to changing to **`syslog-ng`**.

IPv4-Only Protocols

There are several protocols which are not IPv6 capable: **`telnet`** (client and server), **`http`**, **`ftp`** and **`dhcpcd`**. Due to their intrinsic insecurity, **`telnet`** and **`ftp`** are repidly being deprecated, and probably have little business running over an IPv6 network. The address autoconfiguration capabilities of IPv6 make the DHCP protocol less important, however it is likely that the new **`dhcpv6`** capability will appear in a future upgrade.

Appendix G

Third-Party Software

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```
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*
* Portions of this software are based upon public domain software
* originally written at the National Center for Supercomputing Applications,
* University of Illinois, Urbana-Champaign.
*/
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Appendix *H*

Specifications

The following accuracy and stability specifications assume a stationary position (not dynamic mode) and the antenna mounted with a full view of the sky.

GPS Receiver:

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

Antenna:

TNC jack in base of antenna housing, Z_{out} = 50Ω
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°C temperature extremes
Mounting via 18" long, ¾" 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).
Rubidium is option. (1×10^{-9} over -20˚ to +70˚ C).
High-Stability Rubidium is option. (1×10^{-10} over -20˚ to +70˚ C).

Time to Lock:

< 5 minutes, typical (TCXO).
< 10 minutes, typical (Rb).

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 GPS lock status.
Network LED: Amber LED pulses to indicate network activity.
Alarm LED: Red LED indicates a serious fault condition exists.

1 PPS Output:

1 PPS: Positive TTL pulse into 50Ω.
User-Selectable Width: 20 us, 1 ms, 100 ms, 500 ms.
User Calibration: +/- 500 microseconds, 1 nanosecond resolution.
Accuracy: < 20 nanoseconds RMS to GPS Time when locked.*
< 10 nanoseconds RMS to GPS Time when locked with 10-Nanosecond Calibration Option.
Alignment: Within 10 ns of the other TTL outputs in this unit (except the optional DDS).
Stability: TDEV < 10 ns, $\tau < 10^5$ seconds, $\sigma_y(\tau) < 1x10^{-13}$ @ $\tau=10^5$ secs.
Rise Time: < 2 ns.
Holdover Accuracy: < 5 microseconds to UTC for up to 24 hours after 72 hours locked to GPS with a maximum of 5° C peak-peak variation in temperature with the Rubidium.
< 1 microsecond with the High-Stability Rubidium.
*< 100 nanoseconds to UTC. Constraints in the official GPS specification prohibit claiming an accuracy to UTC better than 100 nanoseconds.

10M PPS Output:

Signal: Positive TTL pulse into 50Ω.
Accuracy: $< 1 \times 10^{-13}$ to UTC for 24-hour averaging times when locked.
Stability: See
Alignment: Within 10 nanoseconds of the other TTL outputs in this unit.
Stability (Allan Deviation) Table below.

Stability (Allan Deviation) Table:
(Does NOT pertain to the Synthesized Rates (Optional DDS Outputs).)

Tau in Seconds	TCXO	Rb	HS-Rb
1	$1x10^{-9}$	$2x10^{-11}$	$2x10^{-11}$
10	$4x10^{-10}$	$6.7x10^{-12}$	$6.7x10^{-12}$
100	$5x10^{-11}$	$2.5x10^{-12}$	$2x10^{-12}$
1000	$6.5x10^{-12}$	$1.4x10^{-12}$	$9x10^{-13}$
10000	$1x10^{-12}$	$8x10^{-13}$	$5x10^{-13}$
100000	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$

Time Code Output:

Signal: Amplitude-modulated (AM), 3:1 ratio.
Frequency: 1 kHz.
Drive: 1 Vrms into 50Ω.
User-Selectable Formats: IRIG-B120 (IEEE-1344), IRIG-B122, IRIG-B123, NASA-36 or 2137.

Maintenance Console:

Signal: I/O port at RS-232 levels for secure, local terminal access.
Parameters: 19200 baud, 8 data bits, no parity, 1 stop bit.

RTM3204 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

Supported IPv4 Network Protocols:

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
SYSLOG
HTTP

Supported IPv6 Network Protocols:

SSH server with “secure copy” utility, SCP
SNMP v1, v2c, v3 with Enterprise MIB
TIME and DAYTIME server
SYSLOG
Note: See ***Appendix F - IPv6 Information*** for details.

DC Power:

TCXO:	9.5W Maximum; 6W Typical. 24VDC ±20%, 0.5A Maximum
Rubidium:	25W maximum; 12W typical @ 23° C. 24 VDC ±20%, 1.75A maximum.
Connector:	Molex Micro-Fit 3.0 2-pin jack.
Mating Connector:	Molex 43025-0200 / 20-24 AWG Terminal: Molex 43030-0002.

Physical:

Chassis Size:	2.00”H x 4.00”W x 10.00”D
Antenna Size:	3.5” Dia. x 2.5” H
Chassis Weight:	< 3 lb. (1.35 kg.)

Environmental:

Temperature: 0° to +50° C.
Humidity: 0 to 95%, non-condensing.
Storage Temperature: -40° to +85° C.

Optional Fixed Rate Output:

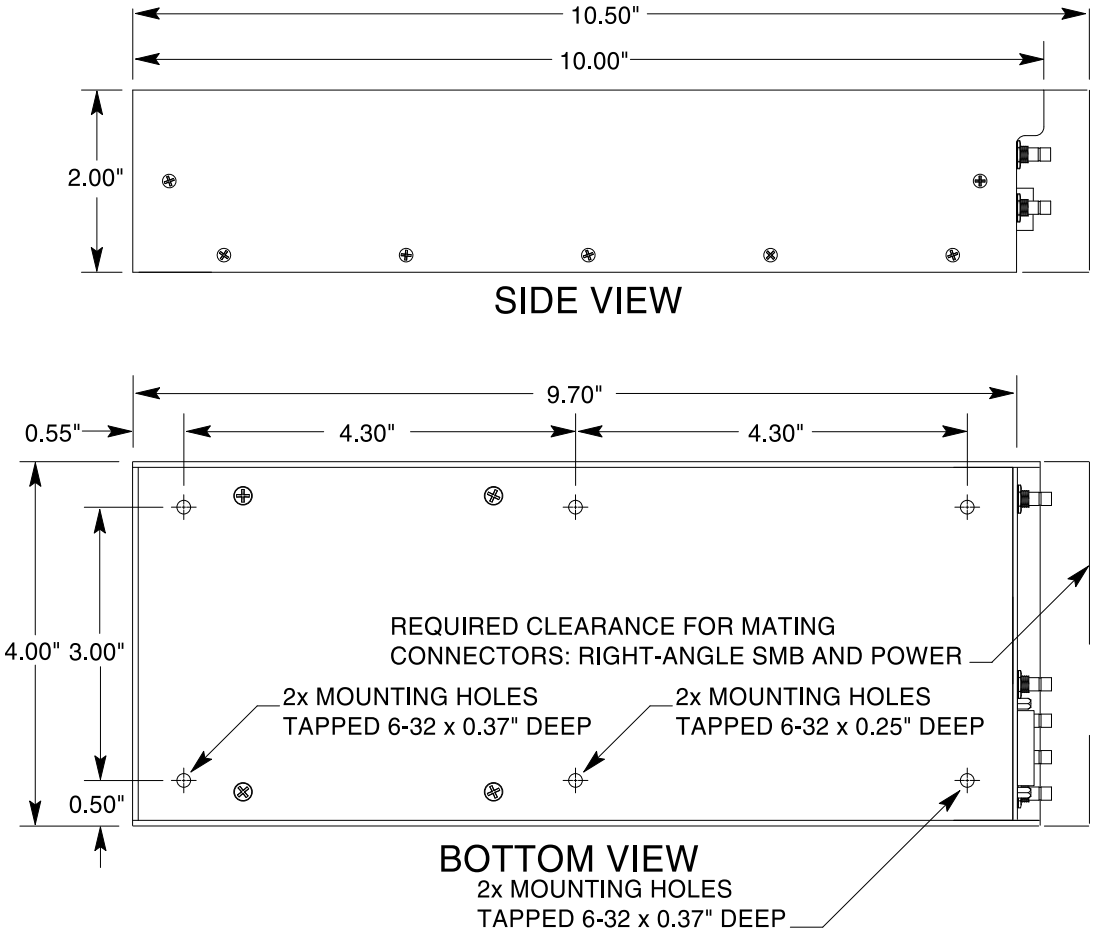
Signal: Positive TTL pulse @ 50Ω.
Rate: Preset at factory and cannot be changed.
Possible rates are: 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS, 1PPM, 1PP2S or Synth.
Duty Cycle: 50% except 1PPS which mimics the standard 1PPS Output.
Accuracy: $< 10^{-13}$ to UTC for 24-hour averaging times when locked.
Alignment: Within 10 ns of the other TTL outputs in this unit (except the optional DDS).
Stability: See Stability (Allan Deviation) Table above.
Synthesized Rate (option): 1 PPS to 10 MPPS in 1 PPS steps with optional DDS Upgrade.

Optional Low Phase Noise Output:

Quantity: 1.
Output Frequency: 10 MHz.
Output Level: +10 dBm, +/- 1 dBm at 50Ω.
Harmonics: < -40 dBc at 50Ω.
Stability: See Stability (Allan Deviation) Table for 10M PPS Output above.
Phase Noise dBc/Hz @ 10 MHz:

Hz	***Rb/HS-Rb***	***Spurs***
1	-80	
10	-100	-120
100	-135	-115
1 k	-140	-125
10 k	-140	-125
100 k	-140	-110

Mounting Dimensions:



Special Modifications

Changes for Customer Requirements

From time to time EndRun Technologies will customize the standard RTM3204 GPS Timing Module for special customer requirements. If your unit has been modified then this section will describe what those changes are.

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