Tycho *CDMA*

Frequency Reference

User Manual

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Preface

Thank you for purchasing the Tycho Frequency Reference. 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 Tycho 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.

The instruments produced by EndRun Technologies have been selected as the timing reference for a variety of industries and applications - computer networks, satellite earth stations, power utilities, test ranges, broadcast and telecommunications systems and more.

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

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About This Manual

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

Introduction – The Tycho, how it works, where to use it, its main features.
Basic Installation – How to connect, configure and test your Tycho.
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 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 nature of the problem and contact you with the cost to repair (parts and labor) and an estimate of the time necessary to complete the work.

Limitation of Liability

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

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Chapter*One*

Introduction

The Tycho CDMA Frequency Reference is a high-performance, cost-effective system that provides highly-precise time and frequency outputs. The Tycho includes 1 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, and SSH is a standard Tycho feature.

Incorporating a dual-frequency receiver with digital cellular (800 MHz) and PCS (1.9 GHz) capability, the Tycho uses the CDMA wireless infrastructure to precisely synchronize itself to Universal Coordinated Time (UTC) to the 10-microseconds level of accuracy. The frequency of the internal oscillator is disciplined to match the frequency of the UTC timescale to the low parts in 10^{12} level of accuracy over 24-hour observation intervals.

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

Main Features

Overview
The Tycho is composed of a Code Division Multiple Access (CDMA) time and frequency engine integrated with an IBM-PC compatible fanless, convection-cooled 133 MHz CPU with integral ethernet interface and a power supply. Non-volatile storage of the embedded Linux operating system and the Tycho application software is via FLASH memory.

Standard Features
In addition to sourcing a precision 1PPS timing reference and an IRIG-B time code output, your Tycho Frequency Reference includes a serial and network port. The Tycho 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 Tycho Frequency Reference with a wide variety of protocols including SNMP with Enterprise MIB, SSH, TELNET, 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 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.

Easy Installation

Its standard 1U high, 19" rack-mountable chassis and indoor-mounted, magnetic-base antenna make installation simpler compared to GPS products. The antenna and rackmount chassis may be mounted in any convenient location. Connect it to your network via the rear panel mounted, 10/100Base-T RJ-45 connector and plug in the AC power cord. Initial network configuration is automatic on networks using the Dynamic Host Configuration Protocol (DHCP).

Free FLASH Upgrades

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

CDMA Timing- How It Works

The CDMA time and frequency engine in the Tycho receives transmissions from base stations, also known as cell sites, that are operating in compliance with the TIA/EIA IS-95 standard for Code Division Multiple Access (CDMA) mobile telecommunications. This system requires a means of synchronizing the base stations throughout the network so that neighboring cells do not interfere with each other and so that calls can be efficiently transferred between the base stations, without interruption, as the mobile user traverses the cell coverage areas. This 'soft hand-off' feature means that the mobile telephone must be able to 'hitlessly' drop one base station and pick up the next one. To do this, the telephone must be able to calculate the relative difference in time between the codes that modulate the signals from each of the base stations, which again, requires that the base stations be synchronized.

The system designers chose the Global Positioning System (GPS), which is itself a CDMA-based system, as the means of maintaining synchronization, and they defined *system time* to be *GPS time*. Each base station throughout the system contains one or more high-performance GPS timing receivers with sophisticated algorithms that control either an extremely stable ovenized quartz crystal oscillator or a Rubidium vapor atomic frequency standard. Such elaborate means are needed to meet the very difficult operating specifications required by the TIA/EIA IS-95 standard. The base station time synchronization must remain within 10 microseconds of GPS time over periods as long as twenty-four hours during which GPS satellite signals might not be available (typically due to antenna/cable failure, damage or vandalism) and in an environment where large ambient temperature swings may occur. Equipment capable of meeting these requirements is at the current state-of-the-art.

The CDMA time and frequency engine in the Tycho receives the same initialization signals transmitted by the base stations that are used by the mobile telephones to establish their synchronization to system time. The mobile telephones cannot communicate in the system until they have established synchronization with the received spread spectrum encoded waveform. Unlike the mobile telephones, once this synchronization has occurred, the CDMA time and frequency engine in the Tycho has all of the information that it needs to perform its function of delivering accurate UTC time to a network of computers. The mobile telephone must decode much more information, establish two-way communications with the base station, and be a paid subscriber to performs its function of placing and receiving calls.

All of this means that during normal operation, the quality of the timing information being transmitted from each of the base stations is virtually a repeat of that directly obtainable from the GPS. The big difference is that the received signal strengths from the base stations are a minimum of 30 dB larger than those from the GPS satellites, which is why you can usually talk on your cell phone indoors. Due to the nature of the IS-95 spread spectrum CDMA modulation scheme, this timing information may be extracted by a well-designed receiver with a precision of a few nanoseconds. The CDMA time and frequency engine in the Tycho does just that, and for this reason, we call our technology 'indirect GPS'.

Where to Use It

First, the Tycho must be deployed in a *cellular* or *PCS* IS-95 CDMA coverage area. *Cellular* is a commonly used term implying that the frequency band for the base station carrier transmissions is 824-895 MHz. This is in contrast to *PCS*, which implies operation in the 1850-1990 MHz frequency band. If available, the Tycho uses the cellular frequency band because it provides much better propagation characteristics in regards to building penetration and maximum receivable range from the transmitter. In regions lacking cellular coverage, the unit can be set to receive the PCS signals. In general, if your CDMA telephone works where you plan to install the Tycho, then your Tycho will work properly there.

Chapter*Two*

Basic Installation

This chapter will guide you through the most basic checkout and physical installation of your Tycho Frequency Reference. 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 Tycho with its standard network interface, basic familiarity with TCP/IP 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 Tycho shipment typically contains:

- Tycho (part # 3020-0001-000 or #3020- variant)

- Tycho User Manual (part #USM3020-0000-000) on CD (part #5102-0001-000)

- IEC 320 AC Power Cord (part #0501-0003-000)
  (This part will not be present if using the DC power option.)

- DB-9F to DB-9F Null Modem Serial I/O Cable (part #0501-0002-000)

- RJ-45 to RJ-45 CAT-5 patch cable, 2 meters (part #0501-0000-000)

- Magnetic mount antenna/cable assembly (part #0502-0007-001)

Tycho Physical Description

Sync LED   This green LED flashes to indicate synchronization status.

Network LED   This amber LED illuminates when the Tycho is connected to the network and flashes when receiving or transmitting packets..

Alarm LED   This red LED illuminates briefly at power-up, and thereafter whenever a serious fault condition exists.

Antenna Jack   This TNC connector mates with the downlead cable from the external antenna.

RS-232 Connector   This DB-9M connector provides the RS-232 serial I/O console interface to the Tycho. This console allows the user to initialize and maintain the Tycho. See *Chapter 3 - RS-232 Serial I/O Port Signal Definitions* for detailed information.

10/100Base-T Jack   This RJ-45 connector mates with the ethernet twisted pair cable from the network.

1PPS Jack   This BNC connector provides the 1PPS Output (TTL). 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 I - Specifications* for the 1PPS Output.

AM Code Jack   This BNC connector provides the amplitude-modulated time code output. The time code output is normally IRIG-B122 when shipped from the factory, but can be changed via the console command `cpuoptsconfig`. Other selections are available. See signal definition in *Appendix I - Specifications* for the AM Code Output.

Alarm Jack   This BNC connector (or terminal strip) provides the optional Alarm
(Option)   Output, and is usually not installed. If installed, see description in *Chapter 4 - Optional Rear-Panel Outputs* and signal definition in *Appendix I - Specifications.*

Prog TTL Jack *(Option)*	This BNC connector provides the optional Programmable TTL Output and is usually not installed. If installed, see description in *Chapter 4 - Optional Rear-Panel Outputs* and signal definition *in Appendix I - Specifications.*
10 MPPS or 100 PPS, etc. *(Option)*	This BNC connector provides an optional customer-specified rate output and is usually not installed. If installed, it will be labeled for the appropriate rate such as "10 MPPS" or "100 PPS", etc. This output is set at the factory and cannot be changed. See details in *Chapter 4 - Optional Rear-Panel Outputs* and signal definition *in Appendix I - Specifications* for the Fixed Rate Output.
1PPS (RS-422) *(Option)*	This optional DB-9M connector provides the 1PPS output at RS-422 levels and is usually not installed.. The pulse width is normally 1 millisecond wide when shipped from the factory but can be changed via command `cpuoptsconfig`. See pinout details in *Appendix I - Specifications* for the 1PPS (RS-422) Output.
Serial Time *(Option)*	This optional DB-9M connector provides the serial I/O interface with a once-per-second ASCII time string output and is usually not installed. For further information refer see description in *Chapter 4 - Optional Rear-Panel Outputs* and *Appendix I - Specifications.*
Output Boards *(Options)*	Your Tycho has two option slots that can be configured with a variety of output buffer modules. In Tycho products these output modules are not field-installable but must be installed at the factory. See *Chapter 4 - Optional Rear-Panel Outputs* for more information.
AC Power Input Jack	This IEC 320 standard three-prong connector provides AC power.
DC Power Input Block	This optional 3-position terminal block provides connection to the DC power source, and replaces the AC power input jack.
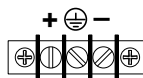
Performing an Initial Site Survey

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

1. Screw the TNC plug on the end of the antenna cable onto the TNC antenna input jack on the chassis rear panel of the Tycho.

2. Plug one end of the supplied AC power cord into an 85-270 VAC outlet.

3. Plug the other end into the AC input connector on the chassis rear panel of the Tycho.

Place the antenna on a flat, preferably metallic surface while the unit is searching for the signal. Make sure that it is not blocked by large metallic objects closer than one meter. Although the antenna should normally be installed in a vertical orientation, usually multipath conditions due to signal re-

flections indoors cause at least some of the signal to be horizontally polarized, so do not be surprised if you find that the unit will work with the antenna oriented either way. Multipath conditions can also cause another effect: signal cancellation. Since the wavelength of the signal is only about 12 to 30 centimeters, movement of the antenna just a few centimeters can sometimes cause significant signal strength changes.

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 has detected a CDMA signal, the green Sync Status LED will begin to flash very slowly (about a .4 Hz rate). Note: If your unit has an oscillator upgrade (MS-OCXO or Rb) then it will need to warm up for 5-10 minutes before attempting to acquire a signal.

4. As the unit locks onto the CDMA signal and begins to decode the timing data, the green Sync Status LED will flash very rapidly (about a 6 Hz rate) until the data is fully decoded.

5. 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 CDMA time and frequency engine has fully synchronized, and you may procede to permanently mount the chassis and antenna in the desired location.

If this sequence has not occurred within twenty minutes (30 minutes with MS-OCXO or Rb), you should move the antenna and/or change its orientation and retry. If you are unable to find an antenna location where the unit will acquire the CDMA signals, you may not have *cellular* coverage in your area or the signal might be too weak in your facility. First, using the `setcdmachannelset` command, try changing the channelset on your unit to operate with the PCS frequencies. If you are still unable to receive signals, you should continue to try for at least a day, since base stations are taken down for service from time to time.

If you have a CDMA phone, see if it will work in *digital* mode. If it will, then your Tycho may be damaged and should be returned to the factory for repair or exchange.

Installing the Tycho

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 Tycho
Using standard 19" rack mounting hardware, mount the unit in the previously surveyed location.

CAUTION
Ground the unit properly with the supplied power cord.
Position the power cord so that you can easily disconnect it from the Tycho.
Do not install the Tycho where the operating ambient temperature might exceed 122°F (50°C).

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

SHOCK/ENERGY HAZARD
Install in Restricted Access Location.
Use 10-14 AWG copper wire only.
Terminal block screw torque: 9 in-lbs (1 nM).
Branch circuit must have circuit breaker, 15A or less.
Install terminal block cover after wiring.

Installing the Antenna
Make sure that the antenna is not blocked by metallic objects that are closer than about one meter. A good location is the top surface of the equipment rack into which the unit has been installed. Ideally it should be mounted vertically, as the transmitted signals are vertically polarized. When indoors, however, multipath conditions may exist. This means that reflected signals may be present with either vertical or horizontal polarization, so your antenna might work in either orientation. After mounting the unit and antenna, verify that it still acquires and tracks a CDMA signal.

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

By factory default, the Tycho will attempt to configure the ethernet interface automatically via the Dynamic Host Configuration Protocol (DHCP). The Tycho 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 Tycho 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 Tycho 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 Tycho 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 Tycho 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 Tycho.

To test serial communications with the Tycho 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 Tycho.

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

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 Tycho 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 Tycho. 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 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 CDMA
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 CDMA 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 TychoCDMA_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 Tycho login prompt is displayed:

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

csys login:
```

Here you may log in as "csysuser" with password "Praecis" or you may log in as the "root" user with password "endrun_1". When logged in as "csysuser", 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 CDMA and shows the software part number, version and build date:

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

This last line is the standard Tycho CDMA shell prompt. The Tycho uses the **bash** shell, which is the Linux standard, full-featured shell. After configuring the unit, you should change the passwords using the **csyspasswd** 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 3 - RS-232 Serial I/O Port Signal Definitions* for the signal connections for the Tycho.

NOTE

You must use a null-modem cable or adapter if you are connecting the Tycho 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 Tycho, you may procede to configuring the network parameters. Then you can communicate with the Tycho 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 Tycho. If you want to have the HTTP Interface enabled in your Tycho 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 CDMA(root@csys)-> netconfig
*******************************************************************************
******************* Tycho CDMA Network Configuration  *******************
*******************************************************************************
*                                                                             *
*   This script will configure the TCP/IP network parameters for your         *
*   Tycho CDMA. 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 CDMA, 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 CDMA. Only the base
hostname is needed, not the domain.
Enter hostname: csys

---DOMAIN name setting

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

---STATIC IP ADDRESS setting

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

---DOMAIN NAMESERVER(S) address setting

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

1. Cycle power to the Tycho.

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

Tycho CDMA(root@csys:~)-> shutdown -r now

If you are using the RS-232 serial I/O port to communicate with the Tycho, 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 ad-

dress and log in to the 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 Tycho 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 CDMA(root@csys:~)-> 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 CDMA(root@csys:~)-> 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 Tycho has been successfully configured to operate on your network and you are ready to check operation of the Tycho 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 CDMA(root@csys:~)-> 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 Tycho 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 Tycho. Alternatively, you could `ping` one of your servers or workstations from the Tycho shell prompt to test the setup.

Once you have successfully established network communications with the Tycho, you may perform all maintenance and monitoring activities via `telnet` and `ftp`. The Tycho provides both client and server operation using `telnet`. For security reasons as well as to reduce the memory footprint in the Tycho, only client operation is supported using `ftp`. You may also monitor the Tycho via the HTTP interface (see *Chapter 5 - HTTP Interface*).

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 Tycho. Both of these protocols are supported in the Tycho 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 Tycho, 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 Tycho, this banner will be displayed:

```
*******************************************************************************
*           Welcome to Tycho CDMA telnet console on:  csys.your.domain
*******************************************************************************

csys login:
```

Here you may log in as "csysuser" with password "Praecis". When logged in as "csysuser", 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 CDMA and shows the software part number, version and build date:

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

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

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

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

```
*********************************************************************************
*              Welcome to Tycho CDMA SSH console on:  csys.your.domain
*********************************************************************************

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

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

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

Using HTTP

You may monitor the status of the Tycho via the HTTP interface. For security reasons, you may not change any settings via the HTTP interface. See *Chapter 5 - 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 `gntppasswd` 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 Tycho

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

If your unit is equipped with the optional Alarm Output, it will be available on a rear-panel BNC jack labeled "ALARM". Care should be taken not to directly connect this open-collector output to a voltage source. A series current limiting resistor of at least 1K ohms in value should be used. The pull-up voltage must not exceed 40V.

If your primary application for the Tycho is as a frequency standard and you have not purchased one of the optional higher-stability oscillators, you should consider operating with console port available to enter the `cdmastat` command. (See *Chapter 3 - Control and Status Commands*.) While using this command you will always know whether the Tycho is currently locked to a CDMA signal while you are performing measurements based on its frequency outputs. The holdover frequency accuracy of the standard TCXO will degrade to the 5×10^{-8} level fairly quickly following signal loss, depending upon the ambient temperature.

Chapter*Three*

Control and Status Commands

This chapter describes the Tycho control and status commands. The Tycho 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 Tycho. However, the Tycho 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 Tycho-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

You do not need to know Linux in order to operate the Tycho. However, for those interested, the command shell used by the Tycho 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 Tycho you should consult the web at:

http://www.tldp.org

Or good Linux reference books like:

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

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

Available User Commands

COMMAND	FUNCTION
accessconfig	Interactive shell script that guides the user in configuring **telnet, ssh** and **snmpd** access to the Tycho 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.
cdmacaldelay	Prints the calibration delay to the console.
cdmachannelset	Prints the current CDMA channelset being used. It can be one of North American Cellular, South Korean Cellular, North American PCS, Indian Cellular or Japanese Cellular.
cdmaleapconfig	Guides the user in configuring the way in which UTC leap seconds are handled: either automatically via CDMA basestation transmissions or by user-entered current and future leap second parameters.
cdmaleapmode	Prints the current CDMA leap second mode of operation, either automatic or user-entered. If user-entered, prints the current and future leap second values.
cdmastat	Prints the CDMA Subsystem status information to the console.
cdmaversion	Prints the CDMA firmware and FPGA version information to the console.
cpuopts	Returns the current settings for any installed, user-selectable outputs from the CPU Module. These are 1PPS, AM Code and the optional Programmable TTL Output.
cpuoptsconfig	An interactive script that allows the user to modify the settings for the CPU Module outputs listed above.
cpusertime	Prints the current settings for the optional Serial Time Output.
cpusertimeconfig	An interactive script that allows the user to modify the settings for the optional Serial Time Output.
csyshwaddr	Prints the ethernet hardware address, if the ethernet has been configured.
csysosctype	Prints the installed oscillator type.
csyspasswd	Allows the *root* user to change the password for the two configured users on the Tycho: *csysuser* and *root*. This script calls the standard Linux **passwd** binary and then saves the resulting */etc/shadow* file to the non-volatile FLASH disk.
csysrootfs	Prints the current root file system image, either TychoCDMA_0 (factory default) or TychoCDMA_1 (field upgrade) which is running in the Tycho to the console.
csystimemode	Prints the time mode settings in effect for the time code output or Serial Time Output.

csystimemodeconfig	Interactive shell script that guides the user in configuring the time mode settings for the time code output or Serial Time Output. Allows setting to the local, GPS or UTC timescale. If local-manual is selected, then the allows configuration of the local offset and Daylight Savings Time (DST) start/stop date parameters.
csysversion	Prints the Linux Subsystem software version information to the console.
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.
help	Prints help for Tycho 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 Tycho.
netconfig	Interactive shell script that allows the user to configure the IP network subsystem of the Tycho.
oscctrlstat	Prints the oscillator disciplining parameters.
pluginopts	Returns the board type and settings for any optional buffer boards. (In Tycho products these options are not "plug-in" but must be installed at the factory.)
pluginoptsconfig	An interactive script that allows the user to change the settings on any configurable option board.
setcdmacaldelay	An interactive script that allows the user to change the clock calibration delay.
setcdmachannelset	Command that allows the user to select the channelset for the CDMA sub-system to receive. This command is not functional in units comfigured for Japanese Cellular operation.
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 TFOM Fault Level.
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.
upgradecdma	Shell script that facilitates the CDMA 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 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 Tycho after running this script for the changes to take effect.

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

cdmacaldelay

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

Query:	**cdmacaldelay**
Tycho response:	+0 nanoseconds

cdmachannelset

This command displays the CDMA channelset currently being used by the CDMA Subsystem. It can be one of: North American Cellular, South Korean Cellular, North American PCS, Indian Cellular or for certain units, Japanese Cellular.

Query:	**cdmachannelset**
Tycho response:	**Channelset is North American PCS**

cdmaleapconfig

Leap seconds affect NTP, UTC and Local Time (not GPS Time). Leap second insertions occur about once every two years. This command starts an interactive shell script that will guide the root user in configuring the way that UTC leap seconds are handled.

There are two different modes for handling leap second insertions: automatic and user-entered. The Tycho is shipped from the factory in user-entered leap second mode with the current and future leap second values set appropriately. You will need to change these values the next time a leap second is pending. The interactive script is very detailed in explaining how these values are obtained and used. There is also more information in *Appendix E - Leap Seconds*.

Query:	**cdmaleapconfig**
Tycho response:	Interactive shell script is started.

cdmaleapmode

This command displays the CDMA leap mode of operation currently configured. There are two modes: automatic and user-entered. If the mode is user-entered, then the values of the configured current and future leap seconds are also displayed.

Query: **cdmaleapmode**
Tycho response:
        CDMA Leap Second Mode is USER: Current LS = 13, Future LS = 13

cdmastat

This command allows the user to query the status of the CDMA Subsystem. During normal opera-tion, a Linux daemon (SYSTIMED) polls the CDMA 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.ssssssssss LS S C PNO AGC VCDAC SN.R F.ERR FLTS

Where:

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

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

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 CDMA.

YEAR   is the year of the UTC timestamp of the most recent information received from the CDMA Subsystem.

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

HH:MM:SS.ssssssss   is the hour, minute, second.subsecond UTC timestamp of the most recent polling request received from the CDMA Subsystem.

LS   is the current 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 (Signal Detected), 2 (Code Locking), 4 (Carrier Locking), 8 (Locked).

C   is the CDMA frequency channel being used, one of 0 thru 61, depending upon the channelset being used:
          For North American Cellular these are:
          0 (Primary A), 1 (Primary B), 2 (Secondary A), 3 (Secondary B)
          For South Korean Cellular these are:

4 (Primary A), 5 (Primary B), 6 (Secondary A), 7 (Secondary B)
For North American PCS these are:
8 (00 A), 9 (01 A), 10 (02 A), 11 (03 A), 12 (04 A), 13 (05 A), 14 (06 A), 15 (07 A),
16 (08 A), 17 (09 A), 18 (10 A),
19 (00 D), 20 (01 D), 21 (02 D) ,
22 (00 B), 23 (01 B), 24 (02 B), 25 (03 B), 26 (04 B), 27 (05 B), 28 (06 B), 29 (07 B),
30 (08 B), 31 (09 B), 32 (10 B)
33 (00 E), 34 (01 E), 35 (02 E)
36 (00 F), 37 (01 F), 38 (02 F)
39 (00 C), 40 (01 C), 41 (02 C), 42 (03 C), 43 (04 C), 44 (05 C),
45 (06 C), 46 (07 C), 47 (08 C), 48 (09 C), 49 (10 C).
For Japanese Cellular these are:
50 (Primary A), 51 (Secondary A)
For Indian Cellular these are:
52 (Sri Lanka 43), 53 (Sri Lanka 146),
54 (India 185), 55 (India 226), 56 (India 267), 57 (India 308),
58 (India 369), 59 (India 410), 60 (India 451), 61 (India 492).

PNO   is the base station pseudonoise offset, 0 to 511 in units of 64 pseudonoise code chips.

AGC   is the automatic gain control DAC byte, 0 to 255 with larger numbers implying higher RF gain. Typical range is 150 to 220.

VCDAC   is the TCXO voltage control DAC word, 0 to 1048575 with larger numbers implying higher TCXO frequency. Typical range is 320000 to 640000.

SN.R   is the carrier signal-to-noise ratio, 0.00 to 99.9, measured in the CDMA sync channel symbol rate bandwidth. Typical range is 2.5 to 11.0.

F.ERR   is the CDMA sync channel frame error rate, 0.000 to 1.000, with a higher number implying more Cyclical Redundancy Check (CRC) failures when processing the sync channel message frames. Higher numbers will correlate with lower signal-to-noise ratios.

FLTS   is the fault status, which displays the current summary status of the CDMA 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	Not Used	No Polling Events	Time Input Fault	Local Osc 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 CDMA signal. Unless the unit is being subjected to out-of-specification environmental conditions, this would indicate that the oscillator frequency has drifted near to the end of life region. This should normally only occur after about ten years of operation. The unit will continue to function until the oscillator frequency finally reaches one of the actual DAC endpoints. The unit should be returned to the factory for oscillator replacement at the customer's convenience.

No Signal Time-Out: This bit indicates that the unit has not been able to acquire a CDMA 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. If the condition persists indefinitely, and a problem with the antenna is not evident, the unit may need to be returned to the factory for repair.

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

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

Local Oscillator Fault: This bit indicates that the receiver Local Oscillator Phase Locked Loop (PLL) synthesizer is either unlocked or has failed. This condition should not normally occur unless the unit is subjected to out-of-specification environmental conditions. Otherwise, this would be a fatal fault and the unit should be returned to the factory for repair (1-877-749-3878).

Time Input Fault: This bit indicates that the microprocessor received an erroneous time input from the CDMA Subsystem. Do NOT do a power cycle in an attempt to clear this fault. If the condition persists please report it to the factory.

No Polling Events: This bit indicates that the CDMA Subsystem is not receiving polling requests 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.

The example response indicates that there has been a period without tracking a CDMA signal that exceeded the time-out period, that there was a FLASH Write Fault and that there is a Local Oscillator PLL fault.

  Query: **cdmastat**
  Tycho response:
  LOCKED TFOM = 6 2001 092 04:48:56.347916732 13 8 1 132 28605 8.6 0.000 001A

cdmaversion

This command displays the firmware and hardware versions of the CDMA Subsystem.

Query: **`cdmaversion`**
Tycho response: **`F/W 1.00 FPGA 0202`**

cpuopts

This command displays the current settings for the installed CPU Module outputs.

Query: **`cpuopts`**
Tycho response: **`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 any installed CPU options. The user-selectable options are: 1PPS, AM Code, and the optional Programmable TTL Output.

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

cpusertime

This command displays the current settings for the optional Serial Time Output. Settings for the three NMEA Sentences are always shown but are only applicable if you have selected NMEA as the Output Format Setting. More information about the various formats is in ***Chapter 4 - Optional Rear-Panel Outputs***.

Query: **`cpusertime`**
Tycho response: **`Current Serial Time Output Baud Rate Setting = 9600`**
                                   `Current Serial Time Output Format Setting = Sysplex`
                                   `Current Serial Time Output Parity Setting = Odd`
                                   `Current NMEA Sentence 1 Setting - ZDA`
                                   `Current NMEA Sentence 2 Setting - NONE`
                                   `Current NMEA Sentence 3 Setting - NONE`

cpusertimeconfig

This command starts an interactive shell script that will allow the root user to change the settings of the optional Serial Time Output. The user-selectable outputs are the format (Sysplex, Truetime, EndRun, EndRunX, NENA0, NENA1, NENA8 and NMEA), the baud rate (4800, 9600, 19200, 57600) and the parity (ODD, EVEN, or NONE). The three NMEA sentences can also be changed but are applicable only if the output format is NMEA. More information about the various formats is in ***Chapter 4 - Optional Rear-Panel Outputs.***

Set: **`cpusertimeconfig`**
Tycho response: Interactive shell script is started.

csyshwaddr

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

    Query: **csyshwaddr**
    Tycho response: **00:0E:FE:00:00:33**

csysosctype

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: **csysosctype**
    Tycho response: **Installed Oscillator is TCXO**

csyspasswd

This command allows the root user to change the passwords of the two configured users on the system: *root* and *csysuser*. Arguments passed to **csyspasswd** 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: **csyspasswd**
    Tycho response: The passwd interactive utility starts.

To change csysuser password:
    Set: **csyspasswd csysuser**
    Tycho response: The passwd interactive utility starts.

csysrootfs

This command displays the currently booted root file system image. It can be either TychoCDMA_0 (factory image) or TychoCDMA_1 (field upgrade image). Refer to ***Appendix B - Upgrading the Firmware*** for detailed instructions on performing the upgrade procedure.

    Query: **csysrootfs**
    Tycho response: **BOOT_IMAGE=TychoCDMA_1**

csystimemode

This command displays the current time mode settings for the time code output or optional Serial Time output. Selections are UTC, GPS, Local-Auto and Local-Manual. The displayed local time offset from UTC is valid in either of the two local modes, but the Daylight Savings Time (DST) start/stop parameters are only valid in the local-manual mode. A positive local time offset implies a longitude east of the Greenwich meridian and that local time is ahead of UTC.

In the local-automatic mode, the local offset from UTC is determined from the CDMA base station transmissions. For more precise and deterministic behavior at the DST changeover times, you should

configure your unit for local-manual operation and set up the local offset and the DST start and stop times using **csystimemodeconfig**.

Query: **csystimemode**
Tycho response: **Time Mode = LOCAL_MANUAL**
                                    Local Time Offset from UTC = -16 (half hours)
                                    DST Start Month = Apr Sunday = 1st Hour = 02
                                    DST Stop Month = Oct Sunday = Last Hour = 02

csystimemodeconfig

This command starts an interactive shell script that will allow the user to configure the time mode of the time code output or optional Serial Time Output. Options are GPS, UTC, Local-Auto and Local-Manual. *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 time mode. If you need to modify this setting, you must run this script as *root*. Settings made using this command are non-volatile.

Set: **csystimemodeconfig**
Tycho response: Interactive shell script is started.

csysversion

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

Query: **csysversion**
Tycho response:
         Tycho CDMA 6010-0042-000 v 1.00 Fri Aug 20 22:38:21 UTC 2004

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 Firmware* for more information.

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

help

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

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

Query: **help cdmastat**
Tycho response: Information specific to the **cdmastat** 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 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 Tycho after running this script for the changes to take effect.

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

> Set: **netconfig**
> 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 CDMA Subsystem control status, either acquiring, tracking, 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 oscillator only.

 Query: **oscctrlstat**
 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 current settings for any installed option boards. See ***Chapter 4 - Optional Rear-Panel Outputs*** for more information on the various option boards. In the Tycho product, five slots are listed, but only two can have option boards installed.

 Query: **pluginopts**
 Tycho response: **Digital Buffer, 2001-0004-012-NC is installed.**
               Port A Current Setting = 10M PPS.
               Port B Current Setting = 5M PPS.
               Port C Current Setting = 10 PPS.
               Port D Current Setting = 10 PPS.

pluginoptsconfig

This command starts an interactive shell script that will allow the root user to change the settings of any installed, user-selectable, option board outputs. In the Tycho product, five slots are listed, but only two can have option boards installed. The user-selectable outputs are all board-specific. For more information see ***Chapter 4 - Optional Rear-Panel Outputs.***

 Set: **pluginoptsconfig**
 Tycho response: Interactive shell script is started.

setcdmacaldelay

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: **setcdmacaldelay**
 Tycho response: Interactive shell script is started.

setcdmachannelset

This command sets the CDMA channelset to be used by the CDMA Subsystem. By factory default, the channelset is North American Cellular, unless the unit is configured for Japanese Cellular operation. In that case the hardware configuration limits operation to only the Japanese Cellular band, and this command will have no affect. The command requires one argument, which may be one of these three strings: NAC (North American Cellular), SKC (South Korean Cellular), NAP (North American PCS), or IND (Indian Cellular).

   Set: `setcdmachannelset NAP`
   Tycho response: `Channelset is North American PCS`

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. Some installations may need to mask this fault when operating the NTP server as a Stratum 2 server. The factory default setting is ENABLED.

   Set: `sigfltmask MASKED`
   Tycho response: `Signal Loss Fault Mask set to MASKED`

settfomfltmask

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`
   Tycho response: `TFOM Fault Level set to 6`

sigfltmask

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

   Query: `sigfltmask`
   Tycho response: `Signal Loss Fault is ENABLED`

tfomfltlvl

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

   Query: `tfomfltlvl`
   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 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**
Tycho response:	**UPGRADE is the default root file system.**
Query:	**updaterootflag 2**
Tycho response:	**UPGRADE is the default root file system.**

upgradecdma

This script allows the user to upgrade the CDMA Subsystem firmware. It requires one argument: the path to the binary file to be uploaded to the CDMA Subsystem. It issues the commands over the serial port to the CDMA Subsystem that are needed to start the X-modem file transfer, and then displays the responses from the CDMA Subsystem to the console. When the X-modem 'C' character appears, indicating that the CDMA 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 CDMA 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 **upgradecdma** script. All other lines are from the CDMA 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 CDMA Subsystem as it comes up. The firmware version should match that of the binary file that was uploaded. See *Performing the CDMA Upgrade* in *Appendix B - Upgrading the Firmware* for more information.

```
    Set:                            upgradecdma /tmp/6010-0020-000.bin
    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/upgradecdma: line 26: 27618 Terminated              cat </dev/arm_user

---You should see the CDMA 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 Tycho. Changing the Linux kernel firmware will enable IPv6 operation and should only be done if you have a requirement for IPv6. See *Appendix G - IPv6 Information* and *Performing the Linux Kernel Upgrade* in *Appendix B - Upgrading the Firmware* for more information.

Set   `upgradekernel /tmp/newkernelimage`

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.

| Tycho 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*

Optional Rear-Panel Outputs

*Your Tycho Frequency Reference supports several output options via the CPU module and up to two additional option cards. Status and user settings for the various output signals can be easily viewed and modified via the standard network port or the RS-232 serial port. See **Appendix I - Specifications** for details on signals and connectors, etc.*

CPU Module Options

Standard rear-panel configuration for the CPU module is the Antenna input, the AM Code output, the 1 PPS output, the RS-232 connector and the ethernet connector. Information for the standard outputs, including getting status and control capability via the user interface is described in the main text of this manual. Refer to **Chapter 3 - Control and Status Commands** for details on the `cpuopts` and `cpuoptsconfig` commands.

In addition to the standard connectors, the CPU module can be configured with optional outputs. These optional outputs include a Programmable TTL Output, a Synthesizer Output, an Alarm Output, and a second RS-232 serial port with a Serial Time Output.
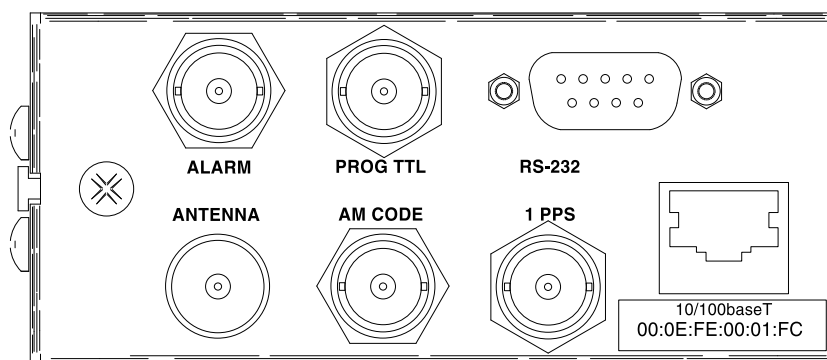
Programmable TTL Output
The Programmable TTL Output option provides user-selectable, on-time pulse rates from 1 PPS to 10 MPPS, or a digital time code. Other selections are 1PPM (pulse per minute), 1PP2S (pulse per 2 seconds/even second), 1PPS+OT (rising edge on time), 1PPS-OT (falling edge on time) and SYNTH (see DDS option below). The output signal can be programmed for any of the various selections via console command `cpuoptsconfig`. Refer to Chapter 3 for details on the `cpuopts` and `cpuoptsconfig` commands. For signal definition see **Appendix I - Specifications**.

Direct Digital Synthesizer (DDS)
The Programmable TTL Output option may be upgraded with the addition of the Direct Digital Synthesizer selection. This option provides user-selectable pulse rates from 1 PPS to 10 MPPS, programmable in 1 PPS steps, including 1.544 MPPS or 2.048 MPPS. The selected pulse rate is phase locked to the system oscillator. However, the DDS output is not aligned with system time.

If your Tycho has this option available then it will show up as "SYNTH" in the list of available selections for the Programmable TTL Output. The actual synthesizer frequency is set via console command **cpuoptsconfig** (see Chapter 3). For signal definition see *Appendix I - Specifications*.

Fixed Pulse Rate Output (10 MPPS, etc.)

The Fixed Pulse Rate Output option provides an optional customer-specified fixed rate output ranging from 1 PPS to 10 MPPS, or a digital time code. The rear-panel BNC will be labeled for the appropriate rate such as "10 MPPS" or "100 PPS", etc. This signal is specified by the customer when the order is placed, preset at the factory, and cannot be changed. There is no user interface status or control. For signal definition see *Appendix I - Specifications*.

1 PPS (RS-422) Output

This option is provided on a second RS-232 serial port which replaces the two upper BNCs on the CPU Module. The pulse width is normally 1 millisecond wide when shipped from the factory but can be changed via console command **cpuoptsconfig**. See signal definition in *Appendix I - Specifications* for the 1PPS RS-422 output.

Alarm Output

The Alarm Output option provides an open-collector output that indicates when the CDMA receiver has lost lock, or when serious hardware faults are detected. For a detailed description of the faults see the **cdmastat** command in *Chapter 3 - Control and Status Commands.* There is no user interface control for this option.

Care should be taken not to directly connect this open-collector output to a voltage source. A series current-limiting resistor of at least 1K ohms in value should be used. The pull-up voltage must not exceed 40V. For signal definition see *Appendix I - Specifications*.

Serial Time Output

This option is provided on a second RS-232 (or RS-422) serial port labeled "Serial Time". It is an output that provides a once-per-second sequence of ASCII characters indicating the current time. The "on-time" character is transmitted at the very beginning of each second, with the leading edge of the start bit transmitted during the first 100 microseconds. The output starts automatically on power-up. See *Appendix I - Specifications* for pinout.

To configure this output refer to *Chapter 3 - Control and Status Commands* for details on the **cpusertime** and **cpusertimeconfig** commands.

There are several different formats for this string. The format, baud rate and parity can all be changed via console command **cpusertimeconfig**. Baud rate selections are 57600, 19200, 9600, and 4800. Parity selections are odd, even, and none. Format selections are Sysplex, Truetime, End-Run, EndRunX, NENA and NMEA.

Sysplex Format

"Sysplex" means SYStem comPLEX and is a term used to describe computing on clusters of computers. The Sysplex option is designed to provide time synchronization for an IBM Sysplex Timer. It can also be used for precise time synchronization by any computer that has an available serial port connection. The time contained in this string format is always UTC time. The following string is sent once each second:

<SOH>DDD:HH:MM:SSQ<CR><LF>

<SOH>	is the ASCII Start-of-Header character (0x01)
DDD	is the day-of-year
:	is the colon character (0x3A)
HH	is the hour of the day
MM	is the minute of the hour
SS	is the second of the minute
Q	is the time quality indicator and may be either:

<space>   ASCII space character (0x20) which indicates locked
?   ASCII question mark (0x3F) which indicates
                the unsynchronized condition

<CR>	is the ASCII carriage return character (0x0D) and is the on-time character, transmitted during the first millisecond of each second.
<LF>	is the ASCII line feed character (0x0A)

Truetime Format

The format of the Truetime string is identical to the Sysplex format. The only difference between the two is that the Sysplex format always uses UTC time. The time contained in the Truetime format depends on the time mode of the Tycho. (See **gsystimemodeconfig** in *Chapter 3 - Control and Status Commands*.) For example, if you want an output with this string format that uses Local Time, then select the Truetime format.

EndRun Format

The time contained in this string depends on the time mode of the Tycho. For example, if you want the time in this string to be UTC, then set the time mode of the Tycho to UTC. (See **gsystimemodeconfig** in *Chapter 3 - Control and Status Commands*.) The following string is sent once each second:

T YYYY DDD HH:MM:SS zZZ m<CR><LF>

T	is the Time Figure of Merit (TFOM) character described in *Appendix A - TFOM*. This is the on-time character, transmitted during the first millisecond of each second.
YYYY	is the year
DDD	is the day-of-year
:	is the colon character (0x3A)
HH	is the hour of the day
MM	is the minute of the hour
SS	is the second of the minute
z	is the sign of the offset to UTC, + implies time is ahead of UTC.
ZZ	is the magnitude of the offset to UTC in units of half-hours. Non-zero only when the Timemode is Local.
m	is the Timemode character and is one of:

G = GPS
L = Local
U = UTC

<CR>	is the ASCII carriage return character (0x0D)
<LF>	is the ASCII line feed character (0x0A)

EndRunX (Extended) Format

The EndRunX format is identical to the EndRun format with the addition of two fields - the current leap second settings and the future leap second settings. The following string is sent once each second:

T YYYY DDD HH:MM:SS zZZ m CC FF<CR><LF>

T	is the Time Figure of Merit (TFOM) character described in ***Appendix A - TFOM***. This is the on-time character, transmitted during the first millisecond of each second.
YYYY	is the year
DDD	is the day-of-year
:	is the colon character (0x3A)
HH	is the hour of the day
MM	is the minute of the hour
SS	is the second of the minute
z	is the sign of the offset to UTC, + implies time is ahead of UTC.
ZZ	is the magnitude of the offset to UTC in units of half-hours. Non-zero only when the Timemode is Local.
m	is the Timemode character and is one of: G = GPS L = Local U = UTC
CC	is the current leap seconds.
FF	is the future leap seconds, which will show a leap second pending 24 hours in advance.
<CR>	is the ASCII carriage return character (0x0D)
<LF>	is the ASCII line feed character (0x0A)

NENA Format

NENA is the National Emergency Number Association. This organization has adopted several ASCII time code formats for use in PSAPs (Public Safety Answering Points) and they are specified in the NENA PSAP Master Clock Standard, Issue 4. These ASCII time code formats are NENA Format 0 (NENA0), NENA Format 1 (NENA1), and NENA Format 8 (NENA8):

NENA0

<CR><LF>Q^^DDD^HH:MM:SS^dTZ=XX<CR><LF>

Q	is the time quality indicator and may be either: <space> ASCII space character (0x20) which indicates locked. ? ASCII question mark (0x3F) which indicates the unsynchronized condition. This is the "on-time" character.
^	is the space character (0x20).
DDD	is the day-of-year (001-366)
:	is the colon character (0x3A)
HH	is the hour-of-the-day (00-23)
MM	is the minute-of-the-hour (00-59)
SS	is the second-of-the-minute (00-60)
d	is the DST indicator (S,I,D,O).
TZ=XX	is the time zone where XX is 00 through 23

<CR>	is the ASCII carriage return character (0x0D).
	The first <CR> is the on-time character.
<LF>	is the ASCII line feed character (0x0A).

NENA1

<CR><LF>Q^WWW^DDMMMYY^HH:MM:SS<CR><LF>

Q	is the time quality indicator and may be either:
	<space> ASCII space character (0x20) which indicates locked.
	? ASCII question mark (0x3F) which indicates the unsynchronized condition.
	This is the "on-time" character.
^	is the space character (0x20).
WWW	is the day-of-week (MON, TUE, WED, THU, FRI, SAT
DD	is the day-of-month (1-31)
MMM	is the month (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC)
YY	is the two-digit year
:	is the colon character (0x3A)
HH	is the hour-of-the-day (00-23)
MM	is the minute-of-the-hour (00-59)
SS	is the second-of-the-minute (00-60)
<CR>	is the ASCII carriage return character (0x0D).
	The first <CR> is the on-time character.
<LF>	is the ASCII line feed character (0x0A)

NENA8

<CR><LF>Q^^YYYY^DDD^HH:MM:SS^D+ZZ<CR><LF>

Q	is the time quality indicator and may be either:
	<space> ASCII space character (0x20) which indicates locked.
	? ASCII question mark (0x3F) which indicates the unsynchronized condition.
	This is the "on-time" character.
^	is the space character (0x20).
YYYY	is the four-digit year
DDD	is the day-of-year (001-366)
:	is the colon character (0x3A)
HH	is the hour-of-the-day (00-23)
MM	is the minute-of-the-hour (00-59)
SS	is the second-of-the-minute (00-60)
d	is the DST indicator (S,I,D,O).
+ZZ	+ or - time zone offset relative to UTC (00-12)
<CR>	is the ASCII carriage return character (0x0D).
	The first <CR> is the on-time character.
<LF>	is the ASCII line feed character (0x0A).

NMEA Format

The National Marine Electronics Association (NMEA) has developed a specification that defines the interface between various pieces of marine electronic equipment. This standard defines "sentences" that contain GPS position, navigation, time, and other information. Sentences that have been added to the Tycho product line are GGA, GLL, GSA, RMC, VTG and ZDA. However, position and navi-

gation information is not available in a CDMA-Synchronized product so the only sentence that has been fully implemented is ZDA (time and date information).

ZDA (Time and Date)

The ZDA sentence identifies the time associated with the current 1PPS pulse. Each sentence is transmitted within 500 milliseconds after the 1PPS pulse is output and tells the time of the pulse that just occurred. If the Tycho is unsynchronized then this sentence will be composed of null fields. Examples are below:

$GPZDA,,,,,,*48<CR><LF>
$GPZDA,175658.00,20,05,2008,07,00*69<CR><LF>

Msg ID	$GPZDA	"$" is the on-time character.
Field 1	175658.00	UTC time at 1PPS (hhmmss.ss)
Field 2	20	Day (01 to 31)
Field 3	05	Month (01 to 12)
Field 4	2008	Year (1980 to 2079)
Field 5	07	Local zone hour, offset from UTC (- for east longitude)
Field 6	00	Local zone minutes, offset from UTC
Checksum	*69	
Msg End	<CR><LF>	

Module Options

Your Tycho Frequency Reference has two available option slots that can be configured with a variety of modules. (In the Tycho these modules are not field-installable - they must be installed at the factory.) Refer to `pluginopts` and `pluginoptsconfig` in *Chapter 3 - Control and Status Commands*. Option modules are described below:

Programmable Digital Buffer Module

The Programmable Digital Buffer Module adds four independently programmable TTL outputs to your Tycho. These buffered outputs can provide on-time pulse rates from 1 PPS to 10 MPPS, or a digital time code output. Other selections are 1PPM (pulse per minute), 1PP2S (pulse per 2 seconds/even second), 1PPS+OT (rising edge on time), 1PPS-OT (falling edge on time) and SYNTH (see DDS option below). Each output can be individually programmed for any of the various selections via console command `pluginoptsconfig` (see Chapter 3). For signal definition see *Appendix I - Specifications*. The rear panel outputs are identified as PROG TTL A through D as shown below:

PROG TTL C   PROG TTL D
DIGITAL BUFFER
PROG TTL A   PROG TTL B
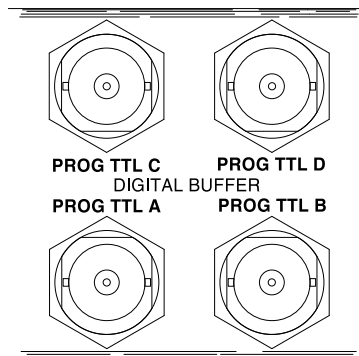
Digital Time Code Formats

If you have selected time code as the output on the Digital Buffer Module then its format will be the same format as that on the standard CPU Module AM Code connector. This format can be changed via console command **cpuoptsconfig** (see Chapter 3).

Direct Digital Synthesizer (DDS)

An additional upgrade to the Programmable Digital Buffer Module provides access to the DDS that is resident on the Tycho CPU module. Programmable synthesized pulse rates from 1 PPS to 10 MPPS in 1 PPS steps are available, including 1.544 MPPS or 2.048 MPPS. The pulse rate is phase locked to the system oscillator. However, the DDS output is not aligned with system time.

If your Tycho has this option available then it will show up as "SYNTH" in the list of available selections for the Programmable Digital Buffer outputs. The actual synthesizer frequency that is resident on the Tycho CPU module is set via console command **cpuoptsconfig** (see Chapter 3).

Digital Buffer Module

The Digital Buffer Module adds four buffered outputs to your Tycho. Signal levels are either TTL (BNC connectors) or RS-232 (DB9M connector). The type of output is set up at the factory based on customer requirements and cannot be changed. Available output types are on-time pulse rates from 1 PPS to 10 MPPS, 1PPM, 1PP2S, or a digital time code, all aligned to system time, or a non-aligned synthesized rate. (Note that for the RS-232 level outputs, rates above 1 MPPS are impractical due to the 30 V/us RS-232 slew rate limit.)

If your Digital Buffer Module is set up for time code or synthesized rates then you can change the time code or rate via console command **cpuoptsconfig**. The module configuration can be viewed by using console command **pluginopts** (see *Chapter 3*). For signal definition and DB9M connector pinout see *Appendix H - Specifications*. The example module below shows a Digital Buffer Module with four 10MPPS Outputs.
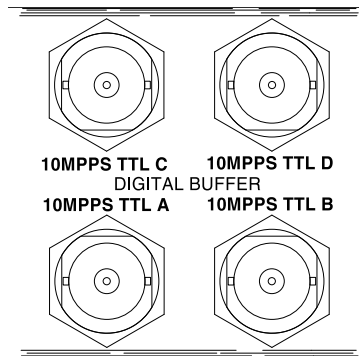
Analog Time Code Buffer Module

The Analog Time Code Buffer Module can provide synchronization of equipment such as synchronized generators, digital fault recorders, SCADA systems, and time displays, and are suitable for recording onto magnetic tape or for transmission over another medium such as coaxial cable. Available time code formats are: IRIG-B120 (IEEE-1344), IRIG-B122, IRIG-B123, NASA-36, or 2137. All four output connectors use the same code format. The format is identical to that of the CPU Module AM Code output which is set via console command **cpuoptsconfig** (see *Chapter 3*). For signal definition see *Appendix I - Specifications*.

AM CODE C   AM CODE D
ANALOG TIMECODE BUFFER
AM CODE A   AM CODE B
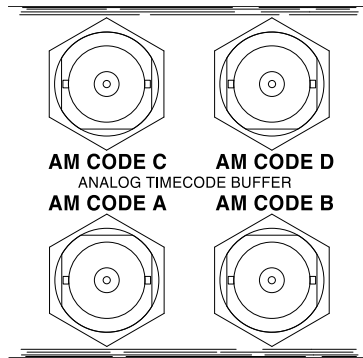
Sine Wave Module

The Sine Wave Output Module is an option that adds four frequency outputs to your Tycho Frequency Reference. This module is intended for those wanting sine wave outputs without the need for the high-performance low-phase-noise.

One or two of these modules can be installed. Available frequencies are 1 MHz, 5 MHz and 10 MHz. The rear-panel outputs are labeled with their configured frequency. These frequencies are not changeable but can be viewed via the network or serial ports by using console command `plugi-nopts` (see Chapter 3). For signal definition see *Appendix I - Specifications*.

10MHz SINE   10MHz SINE
OSC/SINE BUFFER
10MHz SINE   10MHz SINE
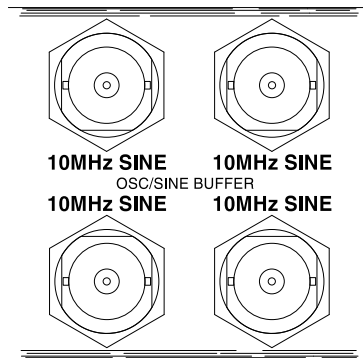
Low Phase Noise Module

The Tycho can be configured with several high-performance, disciplined, 10-MHz oscillators. The low phase noise outputs work in conjunction with these oscillators to provide up to eight individually buffered, spectrally pure, sinewave outputs. The levels of the contributors to spectral impurity have been carefully controlled by the selection of the optional oscillators that are offered, and by the design of the option module and its integration into the Tycho chassis. In addition, very good channel-to-channel isolation has been achieved.

This module always resides in Slot 1 (next to the Receiver/CPU Module). An additional module (without an oscillator) can be installed in Slot 2. The rear-panel outputs are labeled with their configured frequency. These frequencies are not changeable but can be viewed via console command **pluginopts** (see Chapter 3). For signal definition see *Appendix I - Specifications*.

10MHz SINE   10MHz SINE
OSC/LPN BUFFER
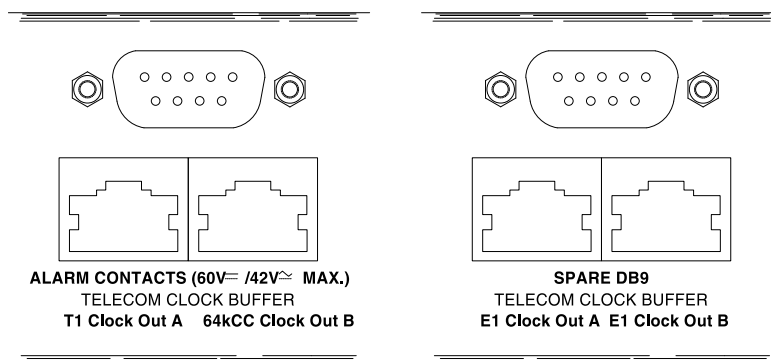10MHz SINE   10MHz SINE
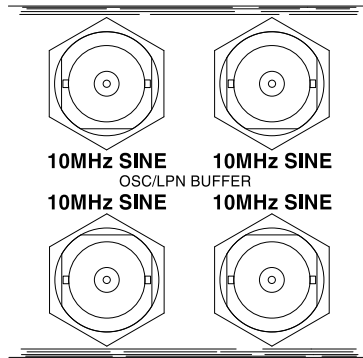
Telecom Clock Module

The Telecom Clock Module adds two or three outputs to your Tycho Frequency Reference. Two outputs are available for any combination of T1, J1, E1 and Composite Clock. An alarm relay output is also available as an additional option. When the Tycho is configured with any of the available oscillator upgrades, it can operate as a Primary Reference Clock, providing high-stability Building Integrated Timing Supply (BITS) clock signals directly to digital equipment. For signal definition see *Appendix I - Specifications*.

SAFETY WARNING

This option does not incorporate over-voltage protection suitable for connection to the public telecommunications network. Do not connect to any wiring that leaves the building.

The rear-panel outputs are labeled with their configuration (E1, T1, J1, 64kCC, Alarm). Examples are below. This configuration cannot be changed but can be viewed via the network or serial ports by using console command **pluginopts**,

ALARM CONTACTS (60V⎓ /42V∼ MAX.)
TELECOM CLOCK BUFFER
T1 Clock Out A   64kCC Clock Out B

SPARE DB9
TELECOM CLOCK BUFFER
E1 Clock Out A E1 Clock Out B

User Settings

There are user settings associated with the T1, J1, E1 and Composite Clock outputs. There are no user settings for the optional Alarm Output. User settings are:

T1/J1:   Framing Mode, Alarm Mode, Line Build-Out
E1:   Framing Mode, Alarm Mode
Composite Clock: Line Code, Alarm Mode

You can view or change the user settings for each output by using the commands **pluginopts** and **pluginoptsconfig** (see *Chapter 3 - Control and Status Commands*). Available selections for each user setting are:

T1 Framing Mode: Unframed, SF (D4) and ESF (CRC6)
T1 Alarm Mode: N/A*, None, AIS, SSM
T1 Line Build-Out: 1-133 feet, 133-266 feet, 266-399 feet, 399-533 feet, 533-655 feet
J1 Framing Mode: SF(D4), ESF(CRC6)
J1 Alarm Mode: None, AIS
J1 Line Build-Out: 0-655 feet
E1 Framing Mode: Unframed,FAS Double-Frame, CRC4 Multi-Frame
E1 Alarm Mode: N/A*, None, AIS, SSM
Comp Clock Line Code: AMI, AMI with 8kHz BPV, AMI with 8kHz BPV+400Hz non-BPV
Comp Clock Alarm Mode: N/A*, None, AIS
*Alarm Mode not applicable when unframed (all ones).

T1 USER SETTINGS VS CLOCK STATUS & ASSOCIATED SIGNAL CONDITIONS

USER SETTINGS	CLOCK STATUS	OUTPUT SIGNAL		
FRAMING/ALARM	ALARM STATE	FRAMING	SSM STATE	SSM Message
UNFRAMED ALARM: N/A	NONE	All 1's	N/A	N/A
	MAJOR (BLUE)	All 1's	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
SF(D4) ALARM: NONE	NONE	SF(D4)	N/A	N/A
	MAJOR (BLUE)	SF(D4)	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
SF(D4) ALARM: AIS	NONE	SF(D4)	N/A	N/A
	MAJOR (BLUE)	AIS(All 1's)	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
ESF ALARM: NONE	NONE	ESF	G.811 Synchronization	11111111 00100000
	MAJOR (BLUE)	ESF	G.811 Synchronization	11111111 00100000
	CRITICAL	All 0's	N/A	N/A
ESF ALARM: AIS	NONE	ESF	G.811 Synchronization	11111111 00100000
	MAJOR (BLUE)	AIS(All 1's)	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
ESF ALARM: SSM	NONE	ESF	G.811 Synchronization	11111111 00100000
	MAJOR (BLUE)	ESF	Do Not Use For Synchronization	11111111 00001100
	CRITICAL	All 0's	N/A	N/A

E1 USER SETTINGS VS CLOCK STATUS & ASSOCIATED SIGNAL CONDITIONS

USER SETTINGS	CLOCK STATUS	OUTPUT SIGNAL		
FRAMING/ALARM	ALARM STATE	FRAMING	SSM STATE	SSM Message
UNFRAMED ALARM: N/A	NONE	All 1's	N/A	N/A
	MAJOR (BLUE)	All 1's	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
FAS DF ALARM: NONE	NONE	FAS DF	N/A	N/A
	MAJOR (BLUE)	FAS DF	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
FAS DF ALARM: AIS	NONE	FAS DF	N/A	N/A
	MAJOR (BLUE)	AIS(All 1's)	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
CRC4 MF ALARM: NONE	NONE	CRC4 MF	G.811 Synchronization	0010
	MAJOR (BLUE)	CRC4 MF	G.811 Synchronization	0010
	CRITICAL	All 0's	N/A	N/A
CRC4 MF ALARM: AIS	NONE	CRC4 MF	G.811 Synchronization	0010
	MAJOR (BLUE)	AIS(All 1's)	N/A	N/A
	CRITICAL	All 0's	N/A	N/A
CRC4 MF ALARM: SSM	NONE	CRC4 MF	G.811 Synchronization	0010
	MAJOR (BLUE)	CRC4 MF	Do Not Use For Synchronization	1111
	CRITICAL	All 0's	N/A	N/A

64kCC USER SETTINGS VS CLOCK STATUS & ASSOCIATED SIGNAL CONDITIONS

USER SETTINGS	CLOCK STATUS	OUTPUT SIGNAL
LINE CODE/ALARM	ALARM STATE	CODE
AMI ALARM: N/A	NONE	AMI - All 1's
	MAJOR (BLUE)	AMI - All 1's
	CRITICAL	All 0's
AMI w/ 8kHz BPV ALARM: NONE	NONE	AMI - All 1's w/ 8kHz Bi-Polar Violation
	MAJOR (BLUE)	AMI - All 1's w/ 8kHz Bi-Polar Violation
	CRITICAL	All 0's
AMI w/ 8kHz BPV ALARM: AIS	NONE	AMI - All 1's w/ 8kHz Bi-Polar Violation
	MAJOR (BLUE)	AMI - All 1's
	CRITICAL	All 0's
AMI w/ 8kHz BPV + 400Hz non-BPV ALARM: NONE	NONE	AMI - All 1's w/ 8kHz Bi-Polar Violation + 400Hz non-Violation
	MAJOR (BLUE)	AMI - All 1's w/ 8kHz Bi-Polar Violation + 400Hz non-Violation
	CRITICAL	All 0's
AMI w/ 8kHz BPV + 400Hz non-BPV ALARM: AIS	NONE	AMI - All 1's w/ 8kHz Bi-Polar Violation + 400Hz non-Violation
	MAJOR (BLUE)	AMI - All 1's
	CRITICAL	All 0's

Alarms

Minor, Major and Critical Alarms are defined below. For further information on each fault refer to the **cdmastat** command (FLTS field) in *Chapter 3 - Control and Status Commands*. In addition to the fault types listed below, there will be a Critical Alarm if a serious hardware problem is detected on the Telecom Module or the CPU Module.

Fault Type	Critical	Major	Minor
DAC Control Over-Range			X
No Signal Time-Out		X	
FPGA Configuration Fault	X		
FLASH Write Fault	X		
Local Oscillator Fault	X		
Time Input Fault		X	
No Polling Events		X	
Antenna Fault			X
Power A Fault (option)			X
Power B Fault (option)			X
MTIE Exceeds 1 Microsecond*		X	

*The first 10 faults listed above are standard system faults. When the telecom board is installed, an additional fault detection algorithm is active that compares the worst case holdover accuracy to the telecom industry standard jitter/wander performance masks. This is the last fault listed in the table above (MTIE Exceeds 1 Microsecond).

The following chart shows the G.823 and T1.101 jitter/wander MTIE mask levels that are pertinent to the telecom option module. In addition, it shows the specified worst case accumulated time error, while in holdover, for the various oscillator options that can be installed with the telecom option. Since the one microsecond level is a good approximate level to the various masks, it is also the threshold level that will induce an immediate fault on the telecom option alarm relays and SSM bits. This level is factory configured and not user settable.

If the Tycho loses CDMA signal lock then it will drift at a rate dependent upon the installed oscillator. When it has drifted more than 1 microsecond the MTIE fault will be set and a Major Alarm will occur. The list below summarizes the chart data. It shows how long in holdover each oscillator will be until it exceeds the one microsecond threshold:

Medium-Stability OCXO: 1 hour
High-Stability OCXO: 3 hours
Ultra-Stable OCXO: 6 hours

**EndRun Disciplined Oscillator Holdover Performance
vs G.823 and T1.101 Jitter/Wander Masks**

5° C Max Delta in Holdover, 7.5°C/hr Max Slew Rate
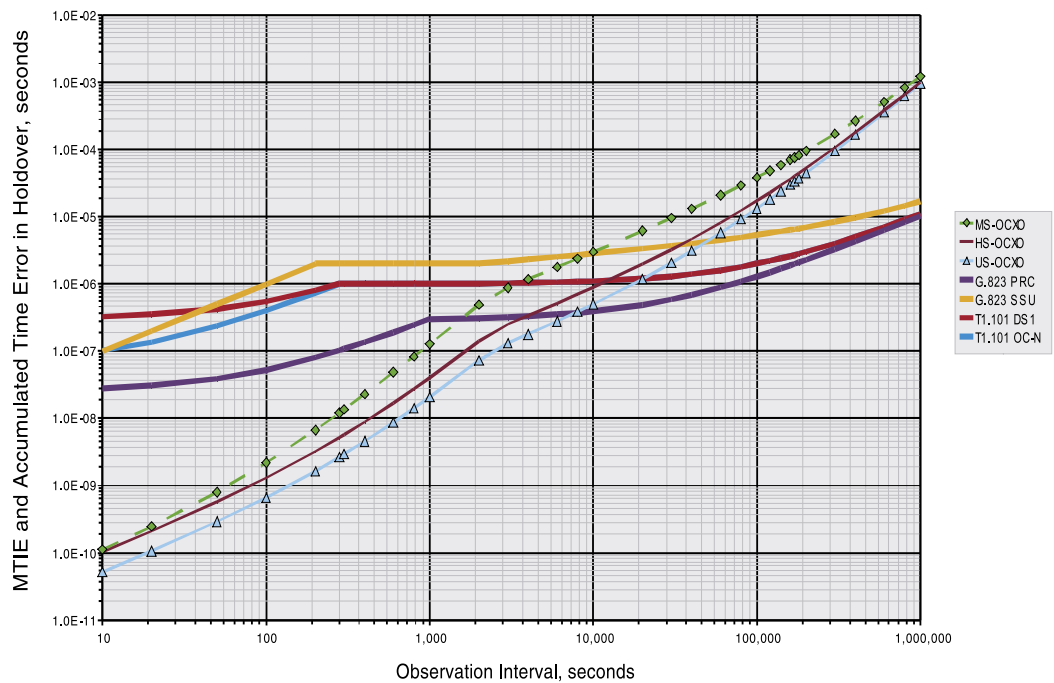
Connectors and Cables

The Telecom Clock Output Module is available with two types of output connectors: BNC and RJ48C. The BNC connector is compatible with 75 ohm coaxial cable. The RJ48C connector is compatible with 100-133 ohm twisted pair. Pin assignments are:

BNC Pinouts

BNC CONNECTOR	SIGNAL
CENTER PIN	XMIT TIP (+SIG)
BARREL	XMIT RING (GND)

RJ48C Pinouts

RJ48C CONNECTOR	SIGNAL
PIN 1	NO CONNECTION
PIN 2	NO CONNECTION
PIN 3	NO CONNECTION
PIN 4	XMIT RING (-SIG)
PIN 5	XMIT TIP (+SIG)
PIN 6	NO CONNECTION
PIN 7	NO CONNECTION
PIN 8	NO CONNECTION

The RJ48C connector is physically identical to an RJ45 connector. The RJ48C designation refers to the interconnection and pairing within the applicable cable, which is different than that of Ethernet cables. The RJ48C wiring pattern is shown below:

RJ48C/RJ48C Crossover Cable Connections / Connector Pin-out

RJ48C SIGNAL	PIN		CABLE WIRE		PIN	RJ48C SIGNAL	
RCV RING (-SIG)	1		PAIR 1 RING		4	XMIT RING (-SIG)	
RCV TIP (+SIG)	2		PAIR 1 TIP		5	XMIT TIP (+SIG)	
NO CONNECTION	3		NONE		3	NO CONNECTION	
XMIT RING (-SIG)	4		PAIR 2 RING		1	RCV RING (-SIG)	
XMIT TIP (+SIG)	5		PAIR 2 TIP		2	RCV TIP (+SIG)	
NO CONNECTION	6		NONE		3	NO CONNECTION	
SHIELD GROUND	7		DRAIN WIRE		7	SHIELD GROUND	
SHIELD GROUND	8		DRAIN WIRE		8	SHIELD GROUND	

Connection to RJ48C BITS Clock Input
A crossover cable, as shown above, would be used to connect the EndRun Technologies clock buffer output on RJ48C pins 4 and 5 to equipment with the BITS clock input on RJ48C pins 1 and 2. Equipment with the BITS clock input on pins 4 and 5 would require a straight-through cable. The shield ground is connected on pins 7 and 8.

Connection to Wire-Wrap Terminal BITS Clock Input
Use a RJ48C cable with 22 AWG solid wire for connection to wire-wrap terminals. Either connector can be cut off to expose the individual twisted-pairs for this application. Determine the color-coding of the twisted-pair connected to pins 4 and 5 of the remaining RJ48C connector. The wire connected to pin 4 connects to the BITS clock Ring input wire-wrap terminal and the wire connected to pin 5 connects to the BITS clock Tip input wire-wrap terminal. The drain wire associated with that shielded twisted pair connects to the GROUND terminal.

Shield Ground Connection
The shield ground should be connected to minimize cross-talk. Connection to BITS clock inputs conforming to the pin-out described in Table 1 or connection as described for wire-wrap inputs will result in a grounded shield. However, some RJ48C BITS clock inputs are wired with the shield connections on pins 3 and 6. This situation can be accommodated by modification or replacement the EndRun-supplied cable. This is compatible with the EndRun Technologies RJ48C clock output connector in which pins 4 and 5 provide the BITS clock signal, while pins 1, 2, 3, 6, 7, and 8 are not connected.

Cable (655 ft maximum)

A 10 ft. T1 crossover cable, manufactured by Stonewall Cable (P/N SC-9598-X) is a good cable for initial testing and typical T1, E1, or 64kCC installations. For other lengths or connector configurations, use equivalent T1 or E1 cable qualified to match clock-type. T1 cable is compatible with E1 signals for short runs. Over 10 ft. use cable specified to match the application. Either cable type can be used for 64kCC signals.

Chapter*Five*

HTTP Interface

This chapter briefly describes the HTTP interface that resides on the Tycho CDMA Frequency Reference. The HTTP interface to the Tycho 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 Tycho and login securely with HTTP. Security-conscious customers may disable the HTTP interface (see the end of this appendix for instructions). Note: The HTTP interface is not IPv6-compliant.

The HTTP interface is not available in older Tycho models. If you have an older model you may want to contact EndRun for information on how to upgrade your Tycho to be HTTP-capable. The older models have a Linux Subsystem part number of 6010-0042-000. To see the software part number enter the **csysversion** command via the network/serial port. The newer Tycho models have (or can have) the HTTP interface capability. These models have a Linux Subsystem part number of 6010-0044-000.

The HTTP implementation in the 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 Command*s) 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 Tycho show status information only. You cannot reconfigure the Tycho except for upgrading firmware, which is done with several security measures in place. To reconfigure the 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:
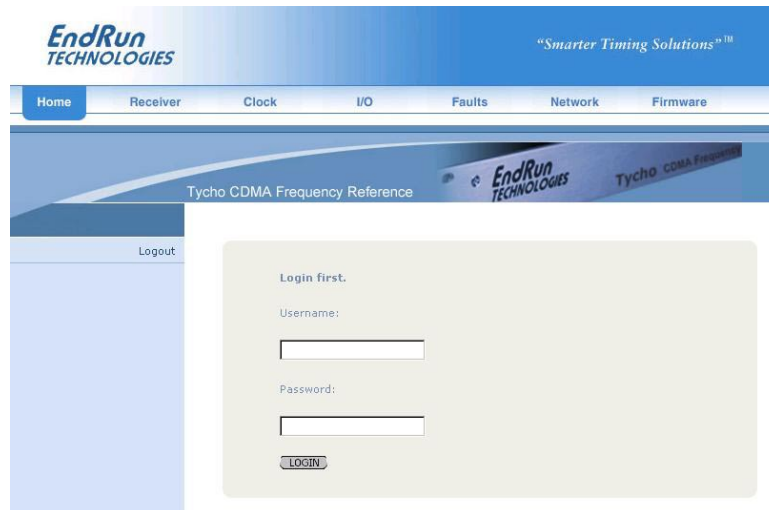
Navigation

The main menu tabs across the top of each webpage allow you to navigate through the status information in the 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 and IPv6. IPv4 is selected.
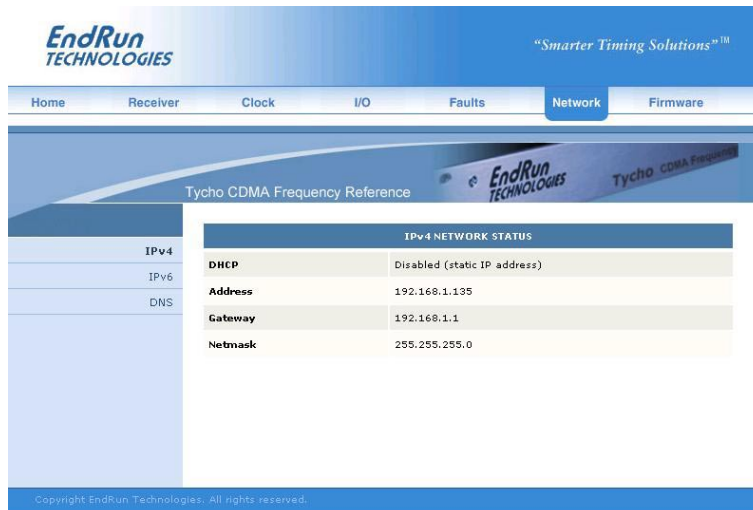
The top-hand tabs and left-side links are logically arranged for easy navigation. The following table defines this relationship:

Tab	Information	Links
Home	Overall Tycho Status Information	Login, Logout
Receiver	CDMA Receiver Status	Receiver, Oscillator
Clock	Clock Status	
I/O	I/O Status (Options)	CPU Options, Plug-In Options
Faults	Fault Status	
Network	IPv4 Network Status	IPv4, IPv6, DNS
Firmware	Firmware Information	Firmware Status, Linux Subsystem Upgrade, CDMA 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 CDMA 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 CDMA Receiver. Data fields are:

State

Shows whether the CDMA receiver is locked or not.

TFOM

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

AGC

This is the automatic gain control (AGC) DAC byte, 0 to 255, with larger numbers implying higher RF gain. With good signal conditions this value is typically 150 to 220.

SNR

The signal-to-noise (SNR) ratio is an indicator of the CDMA signal quality. This number must typically be greater than 2.5 for the instrument to acquire a signal. But once it has locked, it can maintain lock at levels down to about 2.0.

Frame Error Rate

The number shown represents the sync channel frame error rate, 0.000 to 1.000, with a higher number implying more Cyclical Redundancy Check (CRC) failures. Higher numbers will correlate with lower signal-to-noise ratios.

PNO

This is the pseudonoise offset, 0 to 511 in units of 64 pseudonoise code chips. Each base station in an area has a different PNO.

Channel

This is the CDMA frequency channel being used. There are eight possible cellular channels and 42 possible PCS channels. Units configured for operation in Japan have two possible cellular channels.

Channel Set

This shows the current CDMA channelset being used by the CDMA receiver. It can be one of: North America Cellular, Korea Cellular, North America PCS, India Cellular, or Japan Cellular.

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 `setcdmacaldelay` 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 Tycho. It will be either a TCXO or a MS-OCXO. The standard oscillator is the TCXO. If you purchase an oscillator upgrade this field will show MS-OCXO, HS-OCXO or US-OCXO.

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 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, Local-auto and Local-manual. This setting will affect the time displayed on the Time Code Output and any optional Serial Time Output. To change the time mode setting use the front-panel keypad/display or the `csystimemodeconfig` command via the network/serial port. Note: Local-auto derives the local offset and DST from the information embedded in the CDMA timing signal. Local-manual derives the local offset and DST from information entered by the user.

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 **csystimemodeconfig** 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 **csystimemodeconfig** command.

Leap Second Mode, Current Leap Seconds, Future Leap Seconds
Leap seconds affect NTP, UTC and Local Time (not GPS Time). Leap second insertions occur about once every two years. The Tycho has two different modes for handling leap seconds. In automatic leap second mode, the Leap Second Mode field will show Automatic and the Current & Future fields will show the current and future leap seconds as broadcast over the CDMA system. In user-entered leap second mode, the Leap Second Mode field will show User-Entered.

To change the leap second settings, use the front-panel keypad/display or the **cdmaleapconfig** command.

The Tycho is shipped from the factory set for the user-entered mode with current and future leap seconds set appropriately. You will need to change this setting the next time a leap second is pending. Refer to *Appendix E - Leap Seconds* for further information.

I/O Page
This page shows any installed CPU Options and their settings. These are optional outputs that are generated from the CPU Module in the Tycho. A basic Tycho Frequency Reference has two options installed - a 1PPS and a Time Code (AM Code). Other possible CPU Module Options are a Programmable TTL Output and a Serial Time Output. Use commands **cpuoptsconfig** and **cpusertimeconfig** via the network/serial port to change the settings of the CPU Options.

I/O Page (Plug-In Options)
This page shows any installed Plug-In Modules and their settings. Some plug-in modules can be user-configured. Use command **pluginoptsconfig** to change the configuration of these modules.

Faults Page
This page lists all possible fault conditions of the CDMA 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 CDMA 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 CDMA 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.

Polling Events

This fault indicates that the CDMA 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 CDMA Subsystem. Do NOT reset the unit in an attempt to clear this fault. If the condition persists please report it to the factory (1-877-749-3878).

Synthesizer

This fault indicates that the Local Oscillator Phase Locked Loop (PLL) synthesizer is either unlcoked or has failed. This condition should not normally occur unless the unit is subject to out-of-specification environmental conditions. Otherwise, this would be a fatal fault and the unit should be returned to the factory for repair.

Network Page

This page shows the IPv4 network configuration. Fields are:

DHCP

By default, the 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 Tycho does not have IPv6 then there will be no fields on this page. For more information on IPv6 see *Appendix G - 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 CDMA Subsystem firmware.

Linux Subsystem Upgrade, CDMA 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 Tycho firmware are freely available on the End-Run 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 the CDMA 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 CDMA Subsystem. This is normally used after a firmware upgrade but can be done anytime you wish to reset the 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 TFOM is printed out in the time-of-day field printed by the Tycho **cdmastat** *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 6 to 9:*

6	time error is < 100 microseconds
7	time error is < 1 milliseconds
8	time error is < 10 milliseconds
9	time error is > 10 milliseconds, unsynchronized state if never locked to CDMA

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

During periods of signal loss, the CDMA 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 **cdmastat** 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 **tfomfltlvl** and **settfomfltlvl** 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. You may securely upgrade your Tycho firmware via the HTTP interface, the network port, or the serial port. Software upgrades for the 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 Tycho models. These models have a Linux Subsystem root file system (RFS) number of 6010-0042-000. To see the number enter the `csysversion` command via the network/serial port. If you have one of the older Tycho models please proceed to the next section - ***Upgrade Via The Network/Serial Port***.

The newer 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 Tycho models and your current software version is at least 5.50, you may upgrade firmware via the HTTP interface or the network/serial port.

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

1. If your 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 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 CDMA Subsystem.

Note: The address of the Domain Name Server (DNS) for the Tycho must be configured in order to access the EndRun website. Use the `netconfig` command to set up the DNS. (See ***Chapter 2 - Basic Installation, Using netconfig to Set Up Your IP*** for details.

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 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 Tycho via its HTTP interface. Use the link shown above to get the files. After saving the files, use the Tycho HTTP interface to select the previously saved files for upload to the Tycho. One for the Linux Subsystem and the other for the CDMA 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 Tycho. The firmware consists of two FLASH binary image files. One of these is the firmware for the 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 CDMA time and frequency 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 Tycho. This means that you must place the previously downloaded file(s) in a place on your network which is accessible to the 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 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 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 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 Tycho. A command like this should be used:

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

Update the default file system partition by issuing this command on your 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 Tycho using **tel-net** 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

```
csysversion
```

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:

```
csysrootfs
```

Which should cause this to be printed to the console:

```
BOOT_IMAGE=TychoCDMA_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 down-loading the file--either from the EndRun Technologies website or when transferring it to the Tycho.

Recovering from a Failed Upgrade

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

To upgrade your kernel, log in as the *root* user to the 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 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 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 Tycho. A command like this should be used:

```
scp –p 6010-0041-100.bzimage root@csys.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 CDMA Subsystem Upgrade

To perform this upgrade, log in as the *root* user to the 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 CDMA 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 CDMA 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 CDMA 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@csys.your.domain:/tmp
```

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

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

This command is a script that performs the file transfer to the CDMA Subsystem. It first tells the CDMA Subsystem 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 CDMA Subsystem to the console. You should next see this message from the CDMA Subsystem:

```
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/upgradecdma: line 26: 27618 Terminated       cat </dev/arm_user

---You should see the CDMA 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 CDMA Subsystem 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 CDMA Subsystem 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 **upgradecdma** script terminates its execution, and you will again have the standard Tycho console prompt.

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

```
cdmaversion
```

The upgraded version information should be displayed.

Problems with the CDMA 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 CDMA Subsystem 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 CDMA Subsystem 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:

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

Recover Command
Sometimes a user will attempt to download the wrong file to the CDMA 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:

upgradecdma /tmp/6010-0020-000_3.01.bin

Appendix C

Simple Network Management Protocol (SNMP)

Your Tycho 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:

TYCHO-MIB

Which is located on your Tycho in this ASCII file:

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

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

- CDMA Fault Status change
- CDMA 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 "TychoCDMA" 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    TychoCDMA
```

Configuring SNMPv1 Trap Generation

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

Configuring SNMPv2c Notifications and Informs

To have your 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 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 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 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 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 TychoCDMA
```

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 pass-

word *TychoCDMA_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 Tycho 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 Tycho 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 Tycho. Others are provided by the additional protocol servers selected for inclusion in your Tycho, and the way that they are configured.

Secure user authentication and session privacy while performing routine monitoring and maintenance tasks are provided by the OpenSSH implementations of the "secure shell" daemon, **sshd** *and its companion "secure copy" utility,* **scp***. The Apache implementation of the Hyper Text Transport Protocol (HTTP) with Secure Sockets Layer (SSL) daemon (***httpd***) provides for a secure, encrypted session with a digital certificate. 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 **csyspasswd** 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

The embedded Linux operating system running in the 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 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 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 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 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 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 Tycho. This means that users on remote hosts may log in to the Tycho via an **ssh** client, but users logged in on the 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 Tycho via **scp** over **ssh** but users logged in on the 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 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 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 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 Tycho. At boot time, the 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 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 SSH, see ***Disable SSH*** above.

HTTP

The HTTP server in the 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*

Leap Seconds

Your Tycho can operate in three different time modes: GPS, UTC and Local. UTC and Local times are affected by leap seconds. This is an additional second that is inserted into UTC in order to keep it in agreement with the Earth's rotation. Leap seconds may only be inserted at UTC midnight on June 30th or on December 31st. Leap second insertions (or transitions) occur about every 2 years.

Your Tycho can automatically get the leap second information from the CDMA transmissions. However, some of the CDMA providers have not implemented this to the level of precision needed for a perfectly smooth transition at UTC midnight on the day of a leap second insertion. To ensure that your Tycho will precisely handle any UTC leap second transitions, your unit has been configured at the factory for the user-entered leap mode.

If you prefer to have your Tycho automatically get its leap second information from the CDMA transmissions then just change the leap mode to automatic. You can do this by using console command **cdmaleapconfig** (see *Chapter 3 - Control and Status Commands*). To view the leap second settings use command **cdmaleapmode**.

In the user-entered leap mode, the current and future leap second values must be manually set. You can do this by using console command **cdmaleapconfig**. When the unit is configured at the factory, the current and future leap second values are set appropriately for the next possible leap second insertion date (June 30th or December 31st). If there is no leap second insertion scheduled, then the same value is set for both the current and future leap seconds. If there is a leap second insertion scheduled, then a future value is set that is one more than the current value.

For example, as of this writing (July 2005) there are 13 leap seconds. The next possible leap second insertion date is December 31st and there WILL be a leap second insertion on that date. After December 31st there will be 14 leap seconds. So, all units shipped from the factory between July 2005 and the end of December 2005 will have a current leap second value of 13 and a future leap second value of 14. Your Tycho will remember the settings and make a perfect leap second transition at midnight on December 31st. If you happen to have your unit powered off on December 31st, then when power is reapplied, it will know that the leap second transition has passed and behave appropriately. After December 31st, your unit will show that both the current and future leap seconds are 14. This will continue as long as there is no new leap second insertion scheduled, probably for many years. When a new leap second insertion is scheduled you will need to alter the current and future values.

The EndRun Technologies' website has a page devoted to notifying users of the next leap second occurrence. It also posts the appropriate current and future leap seconds setting for your Tycho. The appropriate link is:

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

Background Information

Another way to get the leap second information is to go to the International Earth Rotation Service (IERS) website. If a leap second is pending it will be posted by the IERS approximately six months in advance of insertion. This information is available in the latest Bulletin C at the (IERS) website:

http://www.iers.org

Leap seconds are inserted from time-to-time in order to keep UTC, which is derived from atomic time (TAI), in agreement with the Earth's rotation rate. Relative to TAI, the Earth's rotation rate is slowing down. This means that UTC must be retarded periodically in order to maintain agreement between UTC and the apparent daylength. If this were not done, eventually UTC would drift out-of-sync with Earth's day and many astronomical and navigational problems would ensue.

The International Earth Rotation Service (IERS) is the organization responsible for measuring the relationship between UTC and the rotation rate of the Earth. When the difference between UTC and apparent Earth time has exceeded a certain threshold, the IERS coordinates with the Bureau International of the Hour (BIH) to schedule the insertion of a leap second into the UTC time scale.

The IERS publishes Bulletin C about 6 months in advance of each possible leap second insertion point. Leap seconds may only be inserted at UTC midnight of June 30 or December 31. Bulletin C confirms either that a leap second will or will not be inserted at the next possible insertion point. Since the introduction of leap seconds in 1961, they have been added approximately once every 18 months.

The leap seconds which are needed for your Tycho are actually the difference between GPS-UTC. The GPS time scale began on January 6, 1980. At that time, the UTC timescale had already undergone 19 leapsecond insertion events. If you are obtaining your leap second information from the IERS website, you will need to subtract 19 from the TAI-UTC leap second values published there to obtain GPS-UTC, the number needed to set the current and future leap seconds for the Tycho. At the time of this writing in July of 2005, TAI-UTC was 32 seconds and GPS-UTC was 13 seconds.

Appendix*F*

Time Code Formats

A standard feature of your Tycho Frequency Reference is a single time code output available at the rear panel BNC connector identified as AM CODE. A DC-shift time code output is available via the optional Programmable TTL Output on the CPU Module.

The output code format is selectable via a console command. See `cpuoptsconfig` *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-B122/002

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 time code is seconds through day-of-year coded in Binary Coded Decimal (BCD). Reference IRIG Document 104-60.

IRIG-B123/003

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.

IRIG-B 120/000 (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 defined by IEEE standard 1344-1995: 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

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 time code 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 time code 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 1/2 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:

　　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 CDMA.

Appendix *G*

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 Tycho CDMA check the firmware version using the 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*H*

Third-Party Software

The Tycho is running a software product created and/or maintained by open source projects. Open source software comes with its own license. This is printed out for your information below.

The license for the GNU software project requires that we provide you with a copy of all source code covered under the GNU Public License (GPL) at your request. Please contact us with your request and we will mail it to you on a CD. We will charge you a fee for our incurred expenses as allowed for in the license.

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END OF TERMS AND CONDITIONS

Appendix *I*

Specifications

CDMA Receiver:
Cellular Mobile Receive Band – 869-894 MHz (Standard)
North American PCS Mobile Receive Band – 1930-1990 MHz (Standard)
Japanese Cellular Mobile Receive Band – 832-870 MHz (Optional Configuration)
TIA/EIA IS-95 CDMA Pilot and Sync channels.

Antenna:
TNC jack on rear panel, Z_{in} = 50Ω.
Dual Band, 824-896 MHz/1850-1990 MHz,
    magnetic-base monopole with integral 12 ft. RG-58/U cable and TNC plug.
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).
Medium-Stability OCXO (MS-OCXO) (4×10^{-9} over 0° to 70° C) is option.
High-Stability OCXO (HS-OCXO) (1×10^{-9} over 0° to 70° C) is option.
Ultra-Stable OCXO (US-OCXO) (5×10^{-10} over 0° to 70° C) is option.

Time to Lock:
< 5 minutes, typical (TCXO).
< 10 minutes, typical (OCXO).

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

System Status Indicator:
Sync LED: Green LED pulses to indicate CDMA acquisition and lock status.
Network LED: Amber LED indicates network activity.
Alarm LED: Red LED indicates a serious fault condition.

1 PPS Output:
Signal: Positive TTL pulse into 50Ω.
User-Selectable Width: 20 us, 1 ms, 100 ms, 500 ms.
User-Calibration: +/- 500 us, 1 ns resolution.
Accuracy: < 10 microseconds to UTC when locked, typical.
Stability: TDEV < 50 ns, $\tau < 10^4$ seconds.
Rise Time: < 2 nanoseconds.
Connector: Rear-panel BNC labeled"1PPS".
Note: To change the pulse width see the **cpuopts** and **cpuoptsconfig** commands in *Chapter 3 - Control and Status Commands*.

AM Code Output:

Signal: Amplitude-modulated (AM), 3:1 ratio 1 kHz carrier.

Drive: 1 Vrms into 50Ω.

User-Selectable Time Code Formats: IRIG-B (120/IEEE-1344, 122, 123), NASA-36, or 2137.

Connector: Rear-panel BNC labeled "AM CODE".

Note: To change the time code format see the `cpuopts` and `cpuoptsconfig` commands in *Chapter 3 - Control and Status Commands*. Also see *Appendix F - Time Code Formats*.

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.

Connector: Rear-panel DB-9M connector labeled "RS-232". Pinout is shown below.

Note: For operational details see *Chapter 3 - Control and Status Commands*.

Tycho 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 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 Protocols:

SSH server with "secure copy" utility, SCP

SNMP v1, v2c, v3 with Enterprise MIB

TIME and DAYTIME server

SYSLOG

Note: See *Appendix G - IPv6 Information* for details.

Power:

90-264 VAC, 47-63 Hz, 0.5 A Max. @ 120 VAC, 0.25 A Max. @ 240 VAC

110-370 VDC, 0.5A Max @ 120 VDC

3-Pin IEC 320 on rear panel, 2 meter line cord is included.

Size:

Chassis:	1.75"H x 17.0"W x 10.75"D
Antenna:	2" diameter at base by 14" H.
Weight:	< 5 lb. (2.70 kg.)

Environmental:

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

Optional DC Power:

12 VDC (10-20 VDC), 4A maximum.
24 VDC (19-36 VDC), 2A maximum.
48 VDC (38-72 VDC), 1.5A maximum.
125 VDC (70-160 VDC), 0.75A maximum.
3-position terminal block on rear panel: +DC IN, SAFETY GROUND, -DC IN
(Floating power input: Either "+" or "-" can be connected to earth ground.)

Optional Alarm Output (on CPU Module):

Alarm: MMBT2222A open collector, grounded emitter. High impedance in alarm state.
Voltage: 40 VDC, maximum.
Saturation Current: 100 mA, maximum.
Connector: Rear-panel BNC jack or terminal strip labeled "ALARM".

Optional Serial Time Output (on CPU Module):

Signal: Output only port at RS-232 (or RS-422) levels.
Baud Rate: User-selectable to 4800, 9600, 19200 or 57600.
Parity: User-Selectable to Odd, Even or None.
ASCII Formats: User-Selectable to Sysplex, Truetime, EndRun, EndRunX, NENA or NMEA.
Connector: Rear-panel DB-9M connector labeled "SERIAL TIME".
Pinout (RS-232): Pin 3 is Transmit Data. Pin 5 is GND.
Pinout (RS-422): Pin 3 is +signal. Pin 6 is -signal. Pin 5 is GND.
Note: To change the serial time parameters see the `sertimeopts` and `sertimeoptsconfig` commands in *Chapter 3 - Control and Status Commands*. See more information in *Chapter 4 - Rear-Panel Output Options*.

Optional 1 PPS (RS-422) Output (on CPU Module):

Signal: RS-422 levels.
User-Selectable Width: 20 us, 1 ms, 100 ms, 500 ms.
User Calibration: +/- 500 us, 1 ns resolution.
Accuracy: <10 microseconds to UTC when locked.
Stability: TDEV < 50 ns, $\tau < 10^4$ seconds.
Connector: Rear-panel DB-9M jack labeled "1PPS (RS-422)".
Pinout: Pin 3 is +signal. Pin 6 is -signal. Pin 5 is GND.
Note: To change the pulse width refer to the `cpuopts` and `cpuoptsconfig` commands in *Chapter 3 - Control and Status Commands*.

Optional Programmable TTL Output (on CPU Module):

Signal: Positive TTL pulse @ 50Ω.
User-Selectable Output Type: On-time pulse rate, a digital time code or synthesized rate output.
Pulse Rate: User-selectable to 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS, 1PPM, 1PP2S.
Duty Cycle: 50% except 1PPS which mimics the stndard 1PPS Output.
Accuracy: $< 10^{-11}$ 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 below.
Synthesized Rate (option): 1 PPS to 10 MPPS in 1 PPS steps with optional DDS Upgrade.
Connector: Rear-panel BNC jack labeled "PROG TTL".
Note: To change the output selection refer to the **cpuopts** and **cpuoptsconfig** commands in
Chapter 3 - Control and Status Commands.

Optional Fixed Pulse Rate Output (on CPU Module):

Signal: Positive TTL pulse @ 50Ω.
Rate: Preset at factory and cannot be changed.
Accuracy: $< 10^{-11}$ to UTC for 24-hour averaging times when locked.
Stability: See Stability (Allan Deviation) Table below.
Connector: Rear-panel BNC jack labeled appropriately, i.e. "10 MPPS".
Note: See *Chapter 4 - Rear-Panel Output Options* for more information.

Optional Programmable Digital Buffer Module Outputs:

Quantity: Four outputs.
User-Selectable Output Type: On-time pulse rate, a digital time code or synthesized rate output.
On-Time Pulse Rates:
    Drive: TTL into 50Ω.
    Duty Cycle: 50% except 1PPS which mimics the standard 1PPS Output.
    Rate: User selectable to 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS, 1PPM, 1PP2S.
    Alignment: Within 10 ns of the other TTL outputs in this unit (except the optional DDS).
    Stability: See Stability (Allan Deviation) Table below.
Digital Time Code:
    Drive: TTL into 50Ω (DC level shift).
    Format: User-selectable to IRIG-B (000/IEEE-1344, 002, 003), NASA-36, or 2137.
    Alignment: Within 10 ns of the other TTL outputs in this unit (except the optional DDS).
Synthesized Rate: 1 PPS to 10 MPPS in 1 PPS steps with optional DDS Upgrade.
Connector: Rear-panel BNC jack.
Note: To change the output selection see the **pluginopts** and **pluginoptsconfig** commands in
Chapter 3 - Control and Status Commands. More information in *Chapter 4 - Optional Rear-Panel Outputs*.

Optional Digital Buffer Module Outputs:

Quantity: Four outputs. Type of output is set up at factory based on customer requirements and cannot be changed. Types are: on-time pulse rates, a digital time code or synthesizer.

On-Time Pulse Rates:

    Drive: TTL into 50Ω or RS-232 levels (+/- 5V into 3kΩ; Slew Rate: 30 V/us).

    Duty Cycle: 50% except 1PPS which mimics the standard 1PPS Output.

    Rate: Factory preset to 1, 10, 100, 1K, 10K, 100K, 1M, 5M, or 10M PPS, 1PPM, 1PP2S.

    Stability: See Stability (Allan Deviation) Table below.

    Alignment (TTL): Within 10 ns of the other TTL outputs in this unit (except the optional DDS).

    Alignment (RS-232): The actual realized alignment is a function of the zero-crossing delay as specified above (primarily due to the RS232 slew rate limit) and the actual receiver detection threshold. The alignment of synthesized rate pulses remains fixed following each system initialization, but its relationship to other pulse outputs is non-deterministic. If configured for the 1 PPS output, it can be factory-preset to rising-edge or falling-edge on-time.

Digital Time Code:

    Drive: TTL into 50Ω (DC level shift) or RS-232 levels.

    Format: User-selectable, IRIG-B (002, 003, IEEE-1344 compliant), NASA-36, or 2137.

    Alignment (TTL): Within 10 ns of the other TTL outputs in this unit (except the optional DDS).

    Alignment (RS-232): See Alignment above.

Synthesized Rate: User-selectable, 1 PPS to 10 MPPS in 1 PPS steps.

Connector (TTL): Rear-panel BNC jack.

Connector (RS-232): Rear-panel DB9M.

Pinout (RS-232): Pin 1 is Output A, Pin 2 is Output B, Pin 3 is Output C, Pin 4 is Output D.

Note: See *Chapter 4 - Optional Rear-Panel Outputs, Digital Buffer Module* for more information.

Optional Analog Time Code Buffer Module Outputs:

Quantity: Four outputs.

Signal: Amplitude-modulated (AM), 3:1 ratio, 1 kHz carrier.

Drive: 1 Vrms into 50Ω.

User-Selectable Formats: IRIG-B120 (IEEE-1344), IRIG-B122, IRIG-B123, NASA36 or 2137.

Connector: Rear-panel BNC jack.

Note: To change the time code format see the **cpuopts** and **cpuoptsconfig** commands in *Chapter 3 - Control and Status Commands*. Also refer to *Chapter 4 - Optional Rear-Panel Outputs* and *Appendix F - Time Code Formats* for more information.

Optional Sine Wave Module Outputs:

Quantity: 4 or 8.

Output Frequency: 1 MHz, 5 MHz or 10 MHz.

Output Level: +13 dBm, +/- 2 dBm at 50Ω.

Connector: Rear-panel BNC jack.

Note: See *Chapter 4 - Optional Rear-Panel Outputs* for more information. Also refer to the **pluginopts** command in *Chapter 3 - Control and Status Commands*.

Optional Low Phase Noise Module Outputs:

Quantity: 4 or 8.
Output Frequency: 5 MHz or 10 MHz.
Output Level: +13 dBm, +/- 2 dBm at 50Ω.
Harmonics: < -45 dBc at 50Ω.
Stability: See Stability (Allan Deviation) Table below.
Channel-to-Channel Isolation: > +75 dB
Connector: Rear-panel BNC jack.
Note: See *Chapter 4 - Rear-Panel Output Options* for more information. Also refer to the `plugi-nopts` command in *Chapter 3 - Control and Status Commands*.
Phase Noise dBc/Hz @ 10 MHz:

Hz	*TCXO*	*Spurs (TCXO)*
1	-70	-100
10	-100	-100
100	-125	-100
1 k	-135	-100
10 k	-140	-100
100 k	-145	-120

Hz	*MS-OCXO*	*HS-OCXO*	*US-OCXO*	*Spurs*
1	-95	-105	-110	
10	-120	-130	-135	-120
100	-135	-140	-145	-115
1 k	-145	-150	-150	-125
10 k	-145	-150	-150	-125
100 k	-145	-150	-150	-110

Stability (Allan Deviation) Table:

(Does NOT pertain to the Synthesized Rates (Optional DDS Outputs).)

Tau in Seconds	*TCXO Cellular*	*TCXO PCS*	*MS-OCXO Cellular*	*MS-OCXO PCS*
1	1×10^{-9}	1×10^{-9}	7×10^{-12}	7×10^{-12}
10	1×10^{-9}	1×10^{-9}	1×10^{-11}	2×10^{-11}
100	3×10^{-10}	5×10^{-10}	3×10^{-11}	1×10^{-10}
1000	3×10^{-11}	5×10^{-11}	1×10^{-11}	2×10^{-11}
10000	9×10^{-12}	1×10^{-11}	7×10^{-12}	8×10^{-12}
100000	3×10^{-12}	3×10^{-12}	3×10^{-12}	3×10^{-12}

Optional Telecom Clock Module Outputs:

See *Chapter 4 - Optional Rear-Panel Outputs* for more information. Also refer to the `pluginopts` command in *Chapter 3 - Control and Status Commands*.

COMPOSITE CLOCK
Quantity: 0, 1 or 2.
Type: Transformer-coupled complementary-pair via 2xRJ48C. Single-ended via 2xBNC.
Frequency: 64 kbps.
Synchronization: Phase locked to the Tycho 10 MHz.
Data Format: All ones. User-selectable bipolar violation (BPV).
Line Z: 110Ω nominal (complementary pair), or 75Ω nominal (single-ended).
Pulse Shape: Conforms to ITU-T G.703.
Pulse Amplitude: 3.4V pk into 133Ω, 3.0V pk into 110Ω, 2.4V pk into 75Ω.
MTIE/Jitter/Wander: Conforms to ITU-T G.823.
Line Code: Bipolar Return To Zero, Alternate Mark Inversion (AMI), 5/8 Duty Cycle.
    User-selectable for 64kcc AMI with no BPV, 64kcc AMI with 8 kHz BPV,
    or 64kcc with 8 kHz BPV and missing BPV at 400 Hz.
Alarm Code: User-selectable for BPV off (AIS) at Major (Blue) Alarm, or BPV always on.
    All zeros (LoS) at Critical (Red) Alarm.
Connector: RJ-45 style modular jack (RJ48C-compatible), 1 per output, or BNC (single-ended).
RJ48C Pinout: Pin 4 is Clock Out Ring (-). Pin 5 is Clock Out Tip (-).

E1 CLOCK OUTPUT
Quantity: 0, 1 or 2.
Type: Transformer-coupled complementary-pair via 2xRJ48c or 1xDB9M. Single-ended via 2xBNC.
Frequency: 2.048 Mbps.
Synchronization: Phase locked to the Tycho 10 MHz.
Data Format: All ones. User-selectable for Unframed, Double-frame or CRC4 Multi-frame.
Line Z: 120Ω nominal (complementary pair), or 75Ω nominal (single-ended).
Pulse Shape: Conforms to ITU-T G.703.
Pulse Amplitude: 3.0V pk into 120Ω, 2.2V pk into 75Ω.
MTIE/Jitter/Wander: Conforms to ITU-T G.823.
Line Code: Bipolar Return To Zero, Alternate Mark Inversion (AMI)
    (Identical to HDB3 for all ones data.)
Alarm Code: User-selectable for Alarm Indication Signal (AIS),
    or Status Sync Messaging (SSM) on Sa4 through Sa8, or none at Major (Blue) Alarm.
    All zeros (LoS) at Critical (Red) Alarm.
Connector: RJ-45 style modular jack (RJ48C-compatible), 1 per output, or BNC (single-ended).
RJ48C Pinout: Pin 4 is Clock Out Ring (-). Pin 5 is Clock Out Tip (-).

T1 CLOCK OUTPUT
Quantity: 0, 1 or 2.
Type: Transformer-coupled complementary-pair.
Frequency: 1.544 Mbps.
Synchronization: Phase locked to the Tycho 10 MHz.
Data Format: All ones. User-selectable for Unframed, D4 SuperFrame (SF)
    or CRC6 Extended SuperFrame (ESF).
Line Z: 100Ω nominal.
Pulse Shape: Conforms to ITU-T G.703.
Pulse Amplitude: 3.0V pk.
MTIE/Jitter/Wander: Conforms to ANSI T1 101 and ITU-T G.824.
Line Build-Out: User-selectable for short haul (DSX-1 0-655 ft.
Line Code: Bipolar Return To Zero, Alternate Mark Inversion (AMI)

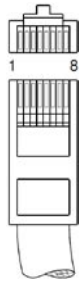(Identical to B8ZS or PDE with all ones data.)

Alarm Code: User-selectable for Alarm Indication Signal (AIS),
  or Status Sync Messaging (SSM), or none at Major (Blue) Alarm.
  All zeros (LoS) at Critical (Red) Alarm.

Connector: RJ-45 style modular jack (RJ48C-compatible), 1 per output.

Pinout: Pin 4 is Clock Out Ring (-). Pin 5 is Clock Out Tip (-).

ALARM RELAY OUTPUTS

Quantity: 0 or 3.

Type: Form C.

Rating: 750 mA @ 42VAC/60VDC.

NC Contact: Closed for alarm-active condition.

NO Contact: Closed for alarm-inactive condition.

Minor Alarm: Active at minor clock faults.

Major Alarm: Active at major clock fault (Blue Alarm).

Critical Alarm: Active at clock operational fault (Red Alarm).

Connector: DB9 Female.

Pinout:	1	Minor NC
	2	Minor NO
	3	Major COM
	4	Critical NC
	5	Critical NO
	6	Minor COM
	7	Major NC
	8	Major NO
	9	Critical COM

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

Supplementary Compliance Data:

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

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

Manufacturer's Name: EndRun Technologies

EndRun
TECHNOLOGIES

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

DECLARES THAT THE PRODUCT

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

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

CONFORMS TO THE FOLLOWING EUROPEAN DIRECTIVES

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

Supplementary Information:

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

Year Mark First Applied: 2004

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

Place: Santa Rosa, California USA   Signature:

Date: December 22, 2004   Full Name: David J. Lobsinger
Position: V. P. Hardware Engineering

Special Modifications

Changes for Customer Requirements

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

This section is blank.