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EndRun TECHNOLOGIES

Præcis Gfr Time and Frequency Reference

User's Manual

ENDRUN TECHNOLOGIES

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User's Manual

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Preface

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

About EndRun Technologies

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

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

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

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

About this manual

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

Introduction – The Præcis Gfr, how it works, where to use it, its main features.
Basic Installation – How to test operation and connect your Præcis Gfr to your equipment.
Setting Up with Computers– Three sections, one for Unix-like platforms and two for Windows NT
Operation – Details of the software and hardware operation.

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.

Trademark acknowledgements

Præcis Gfr User's Manual **Revision 8**

Part No. USM3010-0000-000 **December 2003**

Warranty

This new 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 EndRun Technologies and EndRun Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to EndRun Technologies from another country.

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

Extended Warranty

The standard warranty may be extended beyond the standard two-year period. A record of warranty extension is documented on the sales order for the product purchased. All other conditions of the standard warranty apply for the extended period.

Limitation of Warranty

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

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

Warranty Repair

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

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

Repair After Warranty Expiration

If the warranty period has expired, we offer repair services for equipment you have purchased from EndRun Technologies. 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 would like EndRun Technologies 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 1

Introduction

The Præcis Gfr is a precision source of Universal Coordinated Time (UTC) and Frequency that provides 1 Pulse-Per-Second (1PPS) and 10 MHz outputs. Instrumentation applications may use these signals to achieve time synchronization to typically less than one-hundred nanoseconds and frequency syntonization to less than one part in 10^{12}.

In addition, the Præcis Gfr provides the same computer time synchronization functionality of its sister products, the Præcis Ct, Cf and Cfr, and can be connected to any computer having an RS-232 serial I/O port. In its most basic operation, it broadcasts an ASCII time-of-day message each second with a specific character being the 'on-time' character. The transmission time of this character is accurate to less than one millisecond. More critical computer time synchronization applications using the Network Time Protocol (NTP) may take advantage of the two special signals available on the serial interface that allow synchronization to less than one-hundred microseconds.

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, manuals and other documentation .

GPS Timing–How it Works

GPS satellite transmissions must be synchronized.

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

GPS time is based on an ensemble of cesium beam atomic frequency standards.

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

Each satellite contains redundant cesium beam or rubidium vapor atomic frequency standards.

Each satellite in the constellation contains redundant cesium beam or rubidium vapor atomic frequency standards. These provide the timebase for all transmissions from each satellite. These transmissions are monitored from ground stations located around the world and carefully measured relative to GPS time. The results of these measurements for each satellite are then uploaded to that satellite so that they may be incorporated into the data contained in its transmissions. The receiver can use this data to relate the time-of-arrival of the received transmissions from that satellite to GPS time.

Spread spectrum modulation allows near perfect extraction of the timing information.

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

Where to Use It

GPS is globally available.

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

Just about any system can use the Præcis Gfr.

With the combination of serial I/O support for several time-of-day output message formats, Network Time Protocol support and precision 1 PPS and 10 MHz outputs, the Præcis Gfr offers a functionally complete set of features for a wide variety of laboratory and network synchronization applications.

Main Features

Reliability

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

Flexibility

It supports operation in a variety of modes with a variety of platforms and operating systems.

Easy Installation

Its standard 1U high, 19" rack-mountable chassis and rooftop or window-mounted antenna make installation simpler compared to competing products that require rooftop installation of the antenna. The rack-mount chassis may be mounted in any convenient location. Once the unit is placed near the instrument or computer requiring synchronization, connect the needed signals between the instrument and/or computer and the Præcis Gfr. Then just plug in the AC power cord.

Free FLASH Upgrades

All firmware and configurable hardware parameters are stored in non-volatile FLASH memory, so the Præcis Gfr can be easily upgraded in the field with any terminal program capable of performing file uploads using XMODEM. We make all firmware upgrades to our Præcis products available to our customers free of charge.

Notes

Chapter 2

Basic Installation

This chapter will guide you through the most basic checkout and physical installation of your Præcis Gfr. Subsequent chapters and appendices will give you the information needed to configure your installation for the maximum performance in your operating environment.

Checking and Identifying the Hardware

Unpack and check all the items using the following check list. Contact the factory if anything is missing or damaged.

The Præcis Gfr Hardware Pack (part # 4006-0000-000 or # 4006- variant) contains:

- Præcis Gfr (part # 3010-0000-000 or # 3010- variant)
- Præcis Gfr User's Manual (part # USM3010-0000-000)
- IEC 320 AC Power Cord (Not present if using the DC power option.)
- DB-9M to DB-9F Serial I/O Cable (part # 0501-0005-000)
- Antenna/cable assembly (0610- variant, see packing list for specific part #)

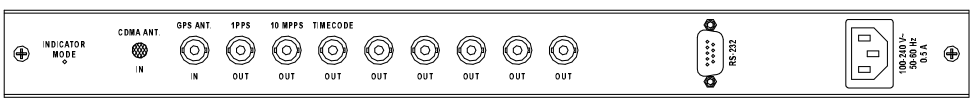
Præcis Gfr Physical Description

Front Panel

Lock Status LED — This green LED flashes to indicate synchronization status.

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

Rear Panel



Indicator Mode Button — The Indicator Mode button is used for:

- Restoring the factory default settings
- Toggling the green LED indicator mode between Normal mode and Signal Quality mode

GPS Ant. Jack — This BNC connector mates with the cable from the external, magnetic mount antenna.

1 PPS Jack — This BNC connector provides the 1 PPS TTL output.

10 MPPS Jack — This BNC connector provides the 10 MPPS TTL output.

Time Code Jack — This BNC connector provides the AM time code output, user-selectable for IRIGB, NASA36, 2137 or IEEE1344.

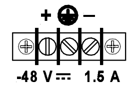
10 MHz, 5 MHz, 1 MHz, 5 MPPS, 1 MPPS, Alarm, Time Code TTL Jack(s) — These BNC connectors are additional optional outputs and may or may not be present on your unit.

RS-232 Serial I/O Jack — This DB-9F connector provides the RS-232 serial I/O status/control interface to the Præcis Gfr. A standard DB-9M to DB-9F cable is required to connect this port to a computer.

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.



Performing an Initial Site Survey

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

1. Screw the BNC plug on the end of the antenna cable onto the BNC antenna input jack on the chassis rear panel of the Præcis Gfr.
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 Præcis Gfr.

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

Initially upon power up:

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

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

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

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

Installing the Præcis Gfr

Mount the Præcis Gfr

CAUTION

Ground the unit properly with the supplied power cord.

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

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

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

Connecting 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 Præcis Gfr has a "floating" internal power supply, therefore either the positive or negative output of the DC power source can be referenced to earth ground.

CAUTION

The Præcis Gfr will not operate while the "+" and "-" power terminals are reverse connected. Units with serial numbers below 03120001 will be severely damaged by reverse connection. Units with serial numbers above 03120001 are protected from damage.

Connect the Serial Port

1. Shutdown the computer and disconnect power from the Præcis Gfr.

2. Connect the DB-9M end of the DB-9M to DB-9F cable to the serial I/O jack on the Præcis Gfr.
3. Connect the DB-9F end of the cable to the appropriate serial I/O port on the computer. If the serial I/O port on your computer does not have a DB9M connector, you may need to use an adapter. Refer to Chapter 3 – *Serial I/O Control and Status Commands* for details on the signal wiring. *Remember which port you are using because you will need to know that in order to set up the terminal software.*
4. Power up the computer.

Test the Serial Port

To test serial communications with the Præcis Gfr you will need a terminal program. You must configure your terminal program to use the serial I/O port you used in *Connect the Serial Port*. You must also configure your terminal program to use the correct baud rate, number of data bits, parity type and number of stop bits. Turn off any handshaking. The factory default settings for the Præcis Gfr are:

- 9600 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 program, apply power to the Præcis Gfr. Within a few seconds, your terminal program should display a sequence of boot messages similar to these:

```
Praecis Bootloader 6010-0000-000 v 3.00 - Feb 06 2002 12:31:03
Praecis Gfr FW 6010-0001-005 v 1.00 - Mar 07 2002 16:41:39
Praecis FPGA 6020-0001-000 v 07
```

The first line gives the part number and version of the Præcis BootLoader firmware and the date and time of its compilation. The second line gives the part number and version of the Praecis Gfr application firmware and the date and time of its compilation. The third line gives the part number and version of the Field Programmable Gate Array (FPGA) configuration.

Following these three lines, factory default operation is to send a time-of-day message once-per-second. The factory default continuous, once-per-second, time-of-day message format is the native Praecis Gfr format:

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

where:

T is the Time Figure Of Merit (TFOM) character and is one of:

9	indicates error > +/- 10 milliseconds, or unsynchronized condition
8	indicates error < +/- 10 milliseconds
7	indicates error < +/- 1 millisecond
6	indicates error < +/- 100 microseconds
5	indicates error < +/- 10 microseconds
4	indicates error < +/- 1 microseconds

YYYY is the year,

DDD is the day of the year,

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 Time Mode is Local.

m is the Time Mode character and is one of:

G = GPS,
L = Local,
U = UTC

<CR> is Carriage Return control character (0x0D)

<LF> is Line Feed control character (0x0A)

Initially, you should see that the TFOM character is a '9'. When the green LED begins to flash at the 1 Hz rate, you should see the character change to a '4', which means that the time is accurate to less than 1 microsecond and the frequency is phase locked.

If you do not see characters displayed by your terminal program when the unit is powered up, you must troubleshoot your setup. An incorrectly wired cable is the most common problem. Refer to Chapter 3 – *Serial I/O Control and Status Commands* for the signal connections for the Præcis Gfr.

Note

It is *not* necessary to use a *null modem* cable or adapter with the Præcis Gfr.

If you are unable to find any errors in your setup, as a last resort you should restore the factory default settings to the Præcis Gfr. It is possible that its serial port parameters are incorrect, so restoring the factory default settings will correct that. Refer to Appendix A – *Indicator Mode Button* for the procedure to restore the factory default settings.

Once you have successfully established communications with the Præcis Gfr, you may proceed to installing and configuring the software you intend to use to synchronize your computer's clock to UTC.

Connecting Instruments to the Præcis Gfr

Rear panel mounted BNC jacks provide the means of connecting your equipment to the Præcis Gfr. The standard Præcis Gfr provides two precision output signals capable of driving properly terminated coaxial cables: 1PPS and 10 MHz. 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. The optional low phase noise, spectrally pure sinewave output(s) are capable of driving 1Vrms into a 50 ohm load. If your unit is equipped with other optional timing or frequency outputs, these will also be designed to drive a 50 ohm load. Care should be taken not to short circuit these outputs or to connect them to other voltage sources.

If your unit is equipped with the optional Alarm Output, it will be available on a rear panel mounted BNC jack. 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 Præcis Gfr is as a frequency standard and you have not purchased one of the optional higher stability oscillators, you should consider operating the LED indicators in the 'Signal Quality Mode'. Refer to Appendix A – *Indicator Mode Button* details. In this mode, you will always know whether the Præcis Gfr is currently locked to a GPS signal while you are performing measurements based on its 10 MHz output frequency. The holdover frequency accuracy of the standard TCXO will degrade to the 5 x 10^{-8} level fairly quickly following GPS signal loss, depending upon the ambient temperature environment.

Notes

Chapter 3

Serial I/O Control and Status Commands

This chapter describes the ASCII protocol supported by the Præcis Gfr. In addition to the Præcis Gfr native commands, the emulation modes which enable use of the Præcis Gfr with existing public domain drivers for various operating systems and platforms are described. The serial I/O port physical and electrical characteristics are defined as well.

General Serial I/O Operation

The Præcis Gfr accepts input commands that are terminated with either an ASCII Carriage Return (CTRL-M, 0x0A) control character (denoted by <CR>) or an ASCII Carriage Return (CTRL-M, 0x0A) - Line Feed (CTRL-J, 0x0D) pair of control characters (denoted by <CR><LF>). Commands are *not* case sensitive. The Præcis Gfr terminates all status messages that it sends in response to commands with a <CR><LF> pair. The Præcis Gfr does not 'echo' any user input.

The Præcis Gfr responds to invalid commands with:

ERROR<CR><LF>

Numerical inputs are accepted in any standard format. For example, all of these formats are acceptable for the decimal number 10:

10, 1E1, 1.0e+1, 10.0, 10E0

At power-up with factory default settings, the Præcis Gfr outputs a time-of-day message once-per-second. The factory default emulation mode is NONE, and the Præcis Gfr sends the time-of-day message in its native format. See *Clock Emulation Modes* for details on these formats.

Available Commands

COMMAND	FUNCTION
ACCUR	Show the user supplied or receiver averaged, accurate GPS reference position
ACCUR=*pos*	Set the accurate GPS reference position, or invalidate the current one.
APPROX	Show the current, unaveraged GPS position fix
APPROX=*pos*	Set the approximate GPS position to assist the GPS engine at cold start at a new location.
CAL	Show the timing calibration factor in seconds
CAL=*c*	Set the timing calibration factor in seconds, where *c* may be -.0005 to +.0005, and + advances the timing outputs.
CTIME	Show the status of the continuous, once-per-second, time-of-day output
CTIME=*e*	Enable or disable the continuous, once-per-second, time-of-day output, where *e* may be ON or OFF.
DSTSTART	Show the setting for the start date of the Daylight Savings Time transition.
DSTSTART=m,s,h	Set the Daylight Savings Time start date, where: m is month: 1-12 s is Sunday of month: 1-4,L for 1st, 2nd, 3rd, 4th, or Last h is the hour of the transition: 0-23 where 0=midnight DSTSTART=0,0,0 will disable Daylight Savings Time.
DSTSTOP	Show the setting for the stop date of the Daylight Savings Time transition.

DSTSTOP=m,s,h	Set the Daylight Savings Time stop date, where: m is month: 1-12 s is Sunday of month: 1-4,L for 1st, 2nd, 3rd, 4th, or Last h is the hour of the transition: 0-23 where 0=midnight DSTSTOP=0,0,0 will disable Daylight Savings Time.
EMUL	Show the continuous, once-per-second, time-of-day emulation mode
EMUL=*m*	Set the continuous, once-per-second, time-of-day emulation mode, where *m* may be NONE, SPECTRACOM, TRIMBLE or TRUETIME.
EVENT	Show the status of event timetagging
EVENT=*e*	Enable or disable event timetagging, where *e* may be ON or OFF.
DYNMODE	Show the dynamic mode setting.
DYNMODE=x	Set the dynamic mode, where x is ON or OFF.
FLTSTAT	Show the summary fault status of the Præcis Gfr
GPSSTAT	Show the current GPS signal processor parameters
HELP	Show the Help menu
LO	Show the local offset setting.
LO=*x*	Set the local offset setting, where: *x* is -12:30 to +12:30 (minutes must be either 00 or 30)
OSCTYPE	Show the oscillator type
PORT	Show the serial port settings
PORT=*b,d,p,s*	Set the serial port settings, where: *b* is baud rate: 9600, 19200, 38400 or 57600 *d* is data bits: 7 or 8 *p* is parity: o, e or n *s* is stop bits: 1 or 2

PPSWIDTH	Show the width of the 1PPS output pulse in milliseconds
PPSWIDTH=*w*	Set the width of the 1PPS output pulse in milliseconds, where *w* may be 1 to 999 or NTP.
RESET	Reset the unit (equivalent to cycling the power).
RESPMODE	Show the command response mode
RESPMODE=*r*	Set the command response mode, where *r* may be TERSE or VERBOSE.
SETTINGS	Show the current user settings
TCODE	Show the time code output setting.
TCODE=c	Set the time code output, where c may be IRIGB, IRIGB+SBS, NASA36, 2137 or IEEE1344.
TFOMFLTLVL	Show the current TFOM fault level setting.
TFOMFLTLVL=*t*	Set the TFOM fault level, where *t* may be 5, 6, 7, 8 or 9
TIME	Show the current time in native Præcis Gfr time-of-day format
TMODE	Show the time mode
TMODE=*m*	Set the time mode, where *m* may be GPS, UTC, or LOCAL.
UPLOAD	Initiates the FLASH upload process
VER	Show the firmware and hardware versions

Detailed Command Descriptions

ACCUR

This command allows the user to query and set the accurate GPS reference position used by the GPS sub-system to determine precision UTC time and frequency. It is used to screen erroneous position fixes from use for precision time and frequency transfer and it provides the reference position needed to operate when only a single satellite is available. The response from a query contains a string of three characters which indicate the source of the position: USR (user-entered), AVG (automatic 24 hour average of GPS fixes), UNK (unknown - no reference position is currently known or trusted for accurate time transfer), or DYN (dynamic - see DYNMODE command). The three dimensional latitude, longitude and height coordinates of the position in degrees, minutes, seconds and meters format follow the three character source string.

A user entered position must be referenced to the World Geodetic Survey of 1984 (WGS-84) geodetic datum and be accurate to at least 100 meters. For precision applications, it should be accurate to the 10 meter level. Refer to Appendix C – *GPS Reference Position* for detailed explanations of the details involved in providing this position information if the receiver is unable to determine it automatically. To invalidate the current accurate position and force the GPS receiver to re-determine it, enter the characters "UNKNOWN". After invalidating the position, no time or frequency information will be available until an accurate position has been re-determined, either via user entry or automatically via a 3-D position fix from the satellites.

Though the Præcis Gfr will average the position fixes over a twenty-four hour period in automatically determining the accurate position, it is not necessary to wait for this average to complete in order to produce usable time and frequency outputs from the Præcis Gfr. Once a single three dimensional fix has been computed, the Præcis Gfr will be able to provide time and frequency based on the reception of signals from at least one satellite.

Usage:

Query: `ACCUR<CR><LF>`

Præcis Gfr response:

`AVG N38d22m31.5s W122d48m42.9s   +32.1 meters<CR><LF>`

Set: `ACCUR=n38d22m31s w122d48m2s 33m<CR><LF>`
`ACCUR=unknown<CR><LF>`

Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: UNK

APPROX

This command allows the user to query and set the approximate GPS position used initially by the GPS sub-system to more rapidly determine its position from a cold start at a new location. It is generally not necessary to provide this information, as the GPS sub-system is capable of automatically determining its own position quite rapidly.

When used as a query, this command returns the current, unaveraged position fix.

Usage:

Query: `APPROX<CR><LF>`
Præcis Gfr response:

`N38d22m31.8s W122d48m41.7s   +22.1 meters<CR><LF>`

Set: `APPROX=n38d22m31s w122d48m41s 32m<CR><LF>`
Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: NONE

CAL

This command allows the user to query and set the value of a calibration offset that the Præcis Gfr can make to the Præcis Gfr timing outputs. It can be useful for compensating various delays present in a system. The units for the offset are seconds. The allowable range is -.0005 seconds to +.0005 seconds, where a positive calibration offset means that the Præcis Gfr timing outputs will be advanced in time. The Præcis Gfr performs this adjustment with a resolution of approximately 32.5 nanoseconds. The example response indicates that the outputs are currently retarded by 123.452 microseconds relative to UTC as received from the GPS satellites. The set value is retained in non-volatile FLASH memory.

The most common use of this command is to compensate for the delay between the antenna and the Præcis Gfr chassis. The RG-59 low-loss cable shipped with the Præcis Gfr adds a delay of approximately 1.4 nanoseconds per foot of cable. When using the standard 50' length of cable, a CAL compensation of +70 nanoseconds is appropriate. The example set command shows how this could be entered.

Usage:

Query: `CAL<CR><LF>`
Præcis Gfr response: `-.000123452<CR><LF>`

Set: `CAL=.00000007<CR><LF>`
Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: 0

CTIME

This command allows the user to query and set the status of the continuous, once-per-second, time-of-day message output. The status is either ON or OFF. Set value is retained in non-volatile FLASH memory.

Usage:

Query:	**CTIME<CR><LF>**
Præcis Gfr response:	**OFF<CR><LF>**
Set:	**CTIME=ON<CR><LF>**
Præcis Gfr response:	**OK<CR><LF>** Then the continuous, once-per-second, time-of-day output message starts, in the format previously selected using the EMUL command.

Factory Default Setting: ON

DSTSTART

This command allows the user to query and set the start time for the Daylight Savings Time transition. (DST affects Local time only. See TMODE command.) Set value is retained in non-volatile FLASH memory. Syntax for the command is DSTSTART=m,s,h. The month of the year, the Sunday of the month, and the hour of the transition all need to be set. For example, in the United States the DST start date is the first Sunday in April at 2:00 a.m. To set this, the command would be DSTSTART=4,1,2. You may disable DST by setting either the DSTSTART or DSTSTOP parameters to 0. For example, DSTSTART=0,0,0.

Month is 1-12.
Sunday is 1-4 for 1st, 2nd, 3rd, 4th or L for last.
Hour is 0-23 where 0 is midnight.

Usage:

Query:	**DSTSTART<CR><LF>**
Præcis Gfr response:	**4,1,2<CR><LF>**
Set:	**DSTSTART=4,1,2<CR><LF>**
Præcis Gfr response:	**OK<CR><LF>**

Factory Default Setting: 0,0,0

DSTSTOP

This command allows the user to query and set the stop time for the Daylight Savings Time transition. (DST affects Local time only. See TMODE command.) Set value is retained in non-volatile FLASH memory. Syntax for the command is DSTSTOP=m,s,h. The month of the year, the Sunday of the month, and the hour of the transition all need to be set. For example, in the United States the DST stop date is the last Sunday in October at 2:00 a.m. To set this, the command would be DSTSTOP=10,L,2. You may disable DST by setting either the DSTSTART or DSTSTOP parameters to 0. For example, DSTSTOP=0,0,0.

Month is 1-12.
Sunday is 1-4 for 1st, 2nd, 3rd, 4th or L for last.
Hour is 0-23 where 0 is midnight.

Usage:

Query:	`DSTSTOP<CR><LF>`
Præcis Gfr response:	`10,L,2<CR><LF>`
Set:	`DSTSTOP=10,L,2<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: 0,0,0

DYNMODE

This command allows the user to query and set whether the unit is in dynamic positioning mode or not. Set value is retained in non-volatile FLASH memory.

When dynamic mode is OFF (the default), it is assumed that the Præcis Gfr is installed in a stationary location. It will use its accurate reference position to implement Timing Receiver Autonomous Integrity Monitoring (TRAIM) for the utmost in reliability during any GPS system faults. In addition, single satellite operation is possible once an initial accurate position has been determined.

When dynamic mode is ON, it is assumed that the Præcis Gfr is installed on a moving platform, such as a ship. In this mode only a very minimal TRAIM algorithm is in effect because the accurate reference position is not static. In addition, a minimum of four satellites must be visible and only 3-D position fixes are used. When the dynamic mode is ON, the source reported for the accurate reference position by the ACCUR command is set to DYN.

Usage:

Query:	`DYNMODE<CR><LF>`
Præcis Gfr response:	`ON<CR><LF>`
Set:	`DYNMODE=OFF<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: OFF

EMUL

This command allows the user to query and set the current clock emulation mode for the continuous, once-per-second, time-of-day message output. There are four allowable emulation modes: NONE, SPECTRACOM, TRIMBLE, and TRUETIME. Set value is retained in non-volatile FLASH memory. See the *Clock Emulation Modes* section of this chapter for details.

Usage:

Query:	`EMUL<CR><LF>`
Præcis Gfr response:	`NONE<CR><LF>`
Set:	`EMUL=trimble<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: NONE

EVENT

This command allows the user to query and set the status of the CTS input event timetagging. The status may be set to either ON or OFF. Set value is retained in non-volatile FLASH memory. When the clock emulation mode is set to TRIMBLE using the EMUL command, the CTS input event timetagging status is forced to ON(TRIMBLE) and attempts to change the status using the EVENT command receive the response 'ERROR<CR><LF>' and are ignored. If CTIME is ON, its output takes priority over these event timetags. It is recommended that CTIME be turned OFF during event timetagging operation. Refer to Appendix E – *Technical Specifications* for event timetagging implementation details.

Usage:

Query:	`EVENT<CR><LF>`
Præcis Gfr response:	`OFF<CR><LF>`
Set:	`EVENT=ON<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>.` Then an Event Time message will be sent following each positive transition of the CTS serial I/O input signal. The Event Time message format is:

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

See the native Præcis Gfr time-of-day message format for the definition of each of these character fields. The Event Time message differs only in that the T character is not on-time, and in the augmentation of the seconds with a decimal point and nine digits (.sssssssss) of sub-second information.

Factory Default Setting: OFF

FLTSTAT

This query-only command displays the current summary status of the Præcis Gfr. 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 sub-system component:

Hex Character	Bit 3	Bit 2	Bit 1	Bit 0
0	FLASH Write Fault	FPGA Config Fault	No Signal Time-Out	DAC Control Over-Range
1	Antenna Fault	Not Used	Not Used	Not Used
2	Not Used	Not Used	Not Used	Not Used
3	Not Used	Not Used	Not Used	Not Used

DAC Control Over-Range — This bit indicates that the electronic frequency control DAC for the TCXO has reached either the high (55000) or low (10000) limit while locked to the GPS signal. Unless the unit is being subjected to out-of-specification environmental conditions, this would indicate that the TCXO 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 TCXO frequency finally reaches one of the actual DAC endpoints. The unit should be returned to the factory for TCXO replacement at the customer's convenience.

No Signal Time-Out — This bit indicates that the unit has not been able to acquire a GPS signal for one hour while the Time Figure of Merit has been equal to or greater than the TFOM fault level. 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 antenna blockage. If the condition persists indefinitely, 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.
Antenna Fault	This bit indicates that the GPS antenna or downlead cable has a fault. It indicates either an over or under current condition. Usually it means that the antenna downlead cable is not plugged into the connector on the rear of the Præcis Gfr. If the condition persists after checking the antenna/downlead for obvious faults, this is a fatal fault and the unit should be returned to the factory for repair.

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

Usage:

Query:	**FLTSTAT<CR><LF>**
Præcis Gfr response:	**0x008A<CR><LF>**
Set:	N/A
Præcis Gfr response:	N/A

Factory Default Setting: N/A

GPSSTAT

This query-only command displays the current status of selected signal processor parameters. This is a fixed-length message formatted as so:

SPS N SVs: S1 S2 S3 S4 S5 S6 S7 S8 DAC: VCDAC SNR: SN.R<CR><LF>

Where:

SPS	is the Signal Processor State, one of ACQ (Acquiring), LKG (Locking Local Oscillator), LKD (Locked).
N	is the number of satellites currently being tracked, 0 to 8.

S1-S8	is the list of satellites being tracked. 0 is an invalid satellite number and indicates that no satellite is being tracked in that channel. Valid numbers range from 1 to 32.
VCDAC	is the TCXO Voltage Control DAC word, 0 to 65535 with larger numbers implying higher TCXO frequency. Typical range is 20000 to 38000.
SN.R	is the average carrier Signal to Noise Ratio, 0.0 to 99.9, measured in the GPS data rate bandwidth. Typical range is 30.0 to 45.0.

Usage:

Query: **GPSSTAT<CR><LF>**
Præcis Gfr response:
LKD 7 SVs: 2 12 22 18 3 25 7 0 DAC: 32368 SNR: 41.2<CR><LF>
Set: N/A
Præcis Gfr response: N/A

Factory Default Setting: N/A

HELP

This query-only command displays a menu of the available status and control commands supported by the Præcis Gfr, along with the syntax of their usage.

Usage:

Query: **HELP<CR><LF>**
Præcis Gfr response: Full menu of available commands and syntax is displayed
Set: N/A
Præcis Gfr response: N/A

Factory Default Setting: N/A

LO

This command allows the user to set or query the local offset setting. This setting is used to compute Local Time if TMODE = LOCAL (see TMODE command) and is retained in non-volatile FLASH memory. The values entered can range from -12:30 to +12:30. The minutes field must be either 00 or 30.

Usage:

Query: **LO<CR><LF>**
Præcis Gfr response: **-7:00<CR><LF>**

Set: `LO=+12:30<CR><LF>`
Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: +0:00

OSCTYPE

This query-only command allows the user to query the oscillator type for this unit. This value is set at the factory and must match the oscillator that is configured in the unit. A variety of OCXOs and Rubidium oscillators are available in addition to the standard TCXO.

Usage:

Query: `OSCTYPE<CR><LF>`
Præcis Gfr response: `TCXO<CR><LF>`

Set: N/A
Præcis Gfr response: N/A

Factory Default Setting: Hardware dependent.

PORT

This command allows the user to query and set the current serial I/O port settings. Changes to the settings take place immediately and are retained in non-volatile FLASH memory. You must change your terminal program to match these settings in order to continue to communicate with the Præcis Gfr. *Restoring the factory default settings may be necessary should you forget the current settings*. See Appendix A – *Indicator Mode Button* for details on restoring the factory default settings. The baud rate, number of data bits, parity and number of stop bits may be set:

Baud rate may be 9600, 19200, 38400, 57600
Number of data bits may be 7 or 8
Parity may be E (even), O (odd) or N (none)
Number of stop bits may be 1 or 2

Usage:

Query: `PORT<CR><LF>`
Præcis Gfr response: `9600,8,N,1<CR><LF>`

Set: `PORT=19200,7,o,2<CR><LF>`
Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: 9600, 8, N, 1

PPSWIDTH

This command allows the user to query and set the current 1PPS output pulsewidth. Set value is retained in non-volatile FLASH memory. The value is in units of milliseconds and may be 1 to 999, or NTP. The NTP setting causes the 1PPS pulsewidth to be automatically set to one bit width at the currently selected baud rate of the serial I/O port. This is for use with the 1PPS on DCD NTP reference clock drivers.

Usage:

Query:	`PPSWIDTH<CR><LF>`
Præcis Gfr response:	`1<CR><LF>`
Set:	`PPSWIDTH=500<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: 1

RESET

This set-only command allows the user to perform a software reset of the unit. It is equivalent to cycling the power on the GPS time and frequency engine.

Usage:

Query:	N/A
Præcis Gfr response:	N/A
Set:	`RESET<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: N/A

RESPMODE

This command allows the user to query and set the current serial I/O command response mode. Set value is retained in non-volatile FLASH memory. In the factory default TERSE mode, all responses to query commands are as described in this chapter. When the response mode is set to VERBOSE, a string consisting of the command name, a space character, the equals sign character and a space character is prepended to the TERSE response string for all query commands except HELP and SETTINGS.

Usage:

Query:	`RESPMODE<CR><LF>`
Præcis Gfr response:	`RESPMODE = VERBOSE<CR><LF>` `TERSE<CR><LF>`
Set:	`RESPMODE=TERSE<CR><LF>`
Præcis Gfr response:	`OK<CR><LF>`

Factory Default Setting: TERSE

SETTINGS

This query-only command displays the current status of all of the user configurable settings. These settings are held in non-volatile FLASH memory.

Usage:

Query:	**SETTINGS<CR><LF>**
Præcis Gfr response:	**Cal = 0.000000000<CR><LF>** **Ctime = OFF<CR><LF>** **Emul = NONE<CR><LF>** **Event = OFF<CR><LF>** **Lo = -7:00<CR><LF>** **Port = 57600,8,N,1<CR><LF>** **PPSwidth = 1<CR><LF>** **Respmode = TERSE<CR><LF>** **Tcode = NASA36<CR><LF>** **TFOMFltLvl = 9<CR><LF>** **Tmode = UTC<CR><LF>**
Set:	N/A
Præcis Gfr response:	N/A

Factory Default Setting: N/A

TCODE

This command allows the user to query and set the current time code output. This is an amplitude-modulated (AM) output via a rear panel BNC. Set value is retained in non-volatile FLASH memory. There are five settings available: IRIGB, IRIGB+SBS, NASA36, 2137 and IEEE1344. The IRIGB setting corresponds to IRIGB122. The IRIGB+SBS setting corresponds to IRIGB123. IEEE1344 is similar to IRIG122 with addition information in the control function bit locations. Refer to Appendix E - Code Formats for detailed IEEE1344 bit description.

Usage:

Query:	**TCODE<CR><LF>**
Præcis Gfr response:	**NASA36<CR><LF>**
Set:	**TCODE=IRIGB+SBS<CR><LF>**
Præcis Gfr response:	**OK<CR><LF>**

Factory Default Setting: IRIGB

This is the setting as shipped by the factory but it will not be affected by the Indicator Mode Button (see Appendix A - Restoring Factory Default Settings). Once the user modifies this setting it will stay that way regardless of resetting factory defaults.

TFOMFLTLVL

This command allows the user to query and set the Time Figure of Merit level at which a "No Signal Timeout" fault will be indicated in the summary fault status word. Set value is retained in non-volatile FLASH memory. Refer to the FLTSTAT command for details of the interpretation of the fault status word. Refer to the manual sections *Clock Emulation Modes* and *Time Figure of Merit/Time Quality* for details on the meanings of these levels in terms of worst case accumulated time error. Allowable entries for setting this parameter are 5, 6, 7, 8 or 9.

Usage:

Query:	**TFOMFLTLVL<CR><LF>**
Præcis Gfr response:	**6<CR><LF>**
Set:	**TFOMFLTLVL=7<CR><LF>**
Præcis Gfr response:	**OK<CR><LF>**

Factory Default Setting: 9

TIME

This query-only command displays the current time-of-day in the native Præcis Gfr format. See the *Clock Emulation Modes* section of this chapter for details. The example response shows the local time and indicates a local offset to UTC of +11.5 hours, meaning that local time is 11.5 hours ahead of UTC. So for this example, UTC time-of-day would be 02:15:01.

Usage:

Query:	**TIME<CR><LF>**
Præcis Gfr response:	**6 2000 155 13:45:01 +23 L<CR><LF>**
Set:	N/A
Præcis Gfr response:	N/A

Factory Default Setting: N/A

TMODE

This command allows the user to query and set the current clock time mode. Set value is retained in non-volatile FLASH memory. **The setting of the time mode has no effect on the continuous, once-per-second, time-of-day messages sent when emulating the Spectracom, Trimble or TrueTime clock types. They are always sent in UTC time.** The time mode setting affects the *native* CTIME, EVENT and TIME time-of-day messages. There are three available time modes:

LOCAL The LOCAL setting will cause the time-of-day to be displayed with the local time zone offset to UTC. The time zone offset is set via the LO command. To set the Daylight Savings Time transition points use the DSTSTART and DSTSTOP commands.

GPS — The GPS setting will cause the time-of-day to be displayed without the leap seconds which have been inserted between the UTC and GPS timescales since the beginning of GPS time: January 6, 1980. At the time of this writing, 13 leap seconds have been applied to UTC since the GPS epoch, so GPS time is currently 13 seconds ahead of UTC time.

UTC — The UTC setting will cause the time-of-day to be displayed as UTC time.

Usage:

Query: `TMODE<CR><LF>`
Præcis Gfr response: `GPS<CR><LF>`

Set: `TMODE=LOCAL<CR><LF>`
Præcis Gfr response: `OK<CR><LF>`

Factory Default Setting: UTC

UPLOAD

This set-only command allows the user to upload a new program to the FLASH memory of the Præcis Gfr. Refer to Appendix B – *Upgrading the Firmware* for detailed instructions for performing the UPLOAD procedure.

Usage:

Query: N/A
Præcis Gfr response: N/A

Set: `UPLOAD<CR><LF>`
Præcis Gfr response:

```
Waiting for download using XMODEM 1K with CRC.<CR><LF>
Control X will abort download.<CR><LF>
CCCC…
```

The 'C' character is sent until the terminal program begins the upload.

Factory Default Setting: N/A

VER

This query-only command displays the firmware and hardware versions.

Usage:

Query: `VER<CR><LF>`

Præcis Gfr response:

```
Praecis Gfr FW 6010-0001-005 v 1.00 - Mar 7 2001 16:41:39 Praecis
FPGA 6020-0001-000 v 07<CR><LF>
```

Set: N/A

Præcis Gfr response: N/A

Factory Default Setting: N/A

Clock Emulation Modes

The Præcis Gfr emulates three industry-standard, continuous, once-per-second, time-of-day message formats in addition to its own native format. Currently these emulated formats are:

NONE

This is the native Præcis Gfr time-of-day message format. It is sent once-per-second, with the TFOM character being the on-time character that is sent during the first millisecond of each second.

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

T is the Time Figure Of Merit (TFOM) character and is one of:

- 9 indicates error > +/- 10 milliseconds, or unsynchronized condition
- 8 indicates error < +/- 10 milliseconds
- 7 indicates error < +/- 1 millisecond
- 6 indicates error < +/- 100 microseconds
- 5 indicates error < +/- 10 microseconds
- 4 indicates error < +/- 1 microsecond

YYYY is the year,
DDD is the day of the year,
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 Time Mode is Local.
m is the Time Mode character and is one of:

G = GPS,
L = Local,
U = UTC

Spectracom

This is WWVB Format 0 and it is sent once each second with the leading <CR> being the on-time character, which is sent during the first millisecond of each second. *The time mode is always UTC in this emulation mode*:

<CR><LF>Q DDD HH:MM:SS TZ=zz<CR><LF>

Q is the Time Quality character,

- ? indicates unsynchronized,
- indicates locked (space character).

DDD is the day-of-year,
HH is the hour-of-the-day,

MM is the minute-of-the-hour,
SS is the second-of-the minute,
zz is the timezone relative to UTC, which is always 0, since time mode is always UTC in this emulation mode.

Trimble

This format is only useful in conjunction with the Trimble Palisade NTP reference clock driver as it is not human readable. It is sent in Trimble Standard Interface Protocol (TSIP) using a binary packet format: *Primary NTP Pkt 8F-AD*. It sends packets for both the CTS assertion events and, if CTIME=ON, the 1PPS events. *It is recommended that 1PPS events be turned off when using this emulation mode by setting CTIME=OFF.* These packets contain a timestamp with 32 nanosecond resolution. When this mode is selected, the native Præcis Gfr CTS input event timetagging function is disabled. *The Time Mode is always UTC in this emulation mode.*

Byte 18, Receiver Status of NTP Pkt 8F-AD contains the synchronization status information. The Præcis Gfr uses three of these codes and they are set in the following manner:

Code 1 (Static 1 Sat. Timing Mode) is set when the time error is < 1 ms
Code 2 (Approximate Time) is set when the time error is < 10 ms
Code 3 (Startup) is set when the time error is > 10 ms

TrueTime

This format is sent once each second with the <CR> being the on-time character, which is sent during the first millisecond of each second. *The Time Mode is always UTC in this emulation mode*:

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

<SOH> is the ASCII Start-of-Header (CTRL-A, 0x01) control character,
DDD is the day-of-year,
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 character, and may be one of the following:

?	indicates the unsynchronized condition
#	indicates error < +/- 50 ms
*	indicates error < +/- 5 ms
.	indicates error < +/- 1 ms
	indicates error < +/- .1 ms (space character)

Time Figure of Merit/Time Quality

The native and emulated time-of-day messages sent by the Præcis Gfr contain a character that indicates the level of accuracy that should be included in the interpretation of the time-of-day contained in the message. In some cases this character is referred to as the 'Time Figure of Merit' (TFOM) while in others it is referred to as the 'Time Quality'.

In all cases, the Præcis Gfr reports this value as accurately as possible, even during periods of GPS signal outage where the Præcis Gfr is unable to directly measure the relationship of its timing outputs to UTC. During these GPS outage periods, assuming that the Præcis Gfr had been synchronized prior to the outage, the Præcis Gfr extrapolates the expected drift of the Præcis Gfr timing signals based on its knowledge of the characteristics of the internal oscillator. The extrapolated TFOM is based on a conservative estimate of the performance of the oscillator and should be considered 'worst case' for a typical benign ambient temperature environment.

Due to this extrapolation behavior, brief losses of satellite reception from a normally operating Præcis Gfr will not induce an immediate alarm condition. If these outages persist for long enough periods, you should see the TFOM character change to indicate a gradually deteriorating accuracy of the timing outputs. If the signal loss condition persists longer, then the TFOM fault level state will eventually be reached (See the TFOMFLTLVL command). If the Præcis Gfr is unable to achieve re-synchronization within one hour after reaching this state, the red LED will illuminate, and in units equipped with the Alarm Output option, the open collector output will transition to the high impedance state. Queries using the FLTSTAT serial I/O command will return with the appropriate bit set to indicate a loss-of-signal time-out condition.

Serial I/O Port Signal Definitions

DB9F Pin	Signal Name
1	Data Carrier Detect (DCD)
2	Transmit Data (TX)
3	Receive Data (RX)
4	N/C
5	Ground
6	N/C
7	Clear To Send (CTS)
8	N/C
9	N/C

Data Carrier Detect (DCD) is driven by the 1PPS signal from the Præcis Gfr. The falling edges are on-time.

Transmit Data (TX) is driven by the Præcis Gfr.

Receive Data (RX) is driven by the host computer.

Ground is connected to the power supply ground on the Præcis Gfr.

Clear To Send (CTS) is driven by Request To Send (RTS) from the host computer. The Præcis Gfr timetags the positive transitions of CTS when CTS input event timetagging is ON (see the EVENT serial I/O command), or the unit is operating in the Trimble Palisade emulation mode.

Chapter 4

Setup with NTP on Unix-like Platforms

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

http://www.ntp.org

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

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

Note

All instruction given here assumes that you are using NTP Version 4. Version 4 is *required* for operation using the Trimble Palisade emulation capabilities of the Præcis Gfr. If you are planning to use the 1PPS capabilities of the Præcis Gfr, upgrading to NTP Version 4 is also recommended. In NTP Version 4 an attempt has been made to reduce some of the platform dependency in using the 1PPS measurements.

You should determine which features are available for your platform that pertain to specific NTP reference clock drivers. In particular, use of the 1PPS input timetagging capabilities of the NTP is somewhat messy and very platform dependent. Some platforms support the 1PPS input timetagging capability natively, others require additional code and a kernel re-compile. You must determine what you need for your platform.

If you only need a few milliseconds of precision, then all platforms will support synchronization using the standard NTP reference clock drivers which merely timetag the receipt of a specific on-time character in the clock's time-of-day message. This is the easiest path to setting up an NTP server and is recommended for all but the most demanding applications. This mode of operation does not make use of the two special signals on the Præcis Gfr serial I/O connector:

Data Carrier Detect (DCD)	The Præcis Gfr drives this signal from its 1PPS output. The falling edge of the DCD output from the Præcis Gfr is on-time, and the negative pulse width is set to one bit width at the selected baud rate.
Clear To Send (CTS)	The Præcis Gfr timetags, with 32 nanosecond resolution, the rising edge of transitions received on the CTS input.

For higher precision applications, the Trimble Palisade NTP reference clock driver is a way around the 1PPS complexity and is recommended if you find that 1PPS operation is too difficult to setup on your platform. This reference clock driver asserts a Request To Send (RTS) on the computer's serial I/O port which is connected via the supplied cable to the CTS input of the Præcis Gfr serial I/O port. When configured for Trimble Palisade emulation mode, the Præcis Gfr timetags the rising edge of this CTS signal, formats the timetag and returns it in a binary message that is compatible with the reference clock driver. Trimble's web site contains extensive documentation concerning the use of the Trimble Palisade with NTP. Much of this subject matter is also helpful in using the Præcis Gfr when it is operating in Trimble Palisade emulation mode:

http://www.trimble.com/oem/ntp/

Three methods of using the Præcis Gfr with NTP on Unix-like platforms will be described, in increasing order of precision:

Basic This is the simplest, and will yield a server whose timing accuracy is on the order of a few milliseconds. It does not use the 1PPS driven DCD output or CTS input event timetagging capabilities of the Præcis Gfr. It does not require special modifications to the kernel and you should be able to use a pre-compiled NTP distribution if one is available for your platform. **NTP beginners and 1PPS users should always perform this setup first.**

Palisade This method is simpler than the 1PPS driven DCD method, and uses the CTS input event timetagging capability of the Præcis Gfr. The precision attainable is comparable to the 1PPS driven DCD output method and is under 100 microseconds. Since this NTP reference clock driver is fairly new, your NTP distribution may not include it. If not, you should download an up-to-date NTP distribution and install it. **Recommended for most users due to the relatively simple set up and high precision attainable.**

1PPS This is more complicated, and will yield a server with precision less than 100 microseconds. It uses the 1PPS driven DCD output capability of the Præcis Gfr. You will have to do more in-depth research and study to understand the interworking between the NTP and the Unix-like kernel. It may require Unix/Linux kernel modifications to support its operation. You may have to re-compile NTP to take advantage of any kernel modifications you made to support 1PPS. **Recommended only for experienced NTP users who are unable to use the Trimble Palisade driver.**

Basic NTP Setup

Basic setup is relatively simple, if:

- You have been able to successfully communicate with the Præcis Gfr and know which serial I/O device on your host computer you are using.
- You have installed NTP version 4 on your host computer.

To complete the setup, these general steps will be performed. The example which follows gives the detailed step-by-step instructions.

1. You must decide which of two clock types you would prefer to have the Præcis Gfr emulate. We will use the TrueTime emulation mode here as an example. Using the Spectracom WWVB, Format 0 is similar.
2. Issue the command to the Præcis Gfr to set it to emulate the TrueTime clock type. Then make sure that the Præcis Gfr serial I/O port parameters are compatible with the TrueTime NTP reference clock driver. Refer to Chapter 1 – *Serial I/O Control and Status Commands* for detailed information on using the serial I/O port with the Præcis Gfr.
3. Now create a symbolic link in your /dev directory which points to the serial I/O port to which your Præcis Gfr is connected. The symbolic link must be called true0, when you are using the TrueTime NTP reference clock driver.
4. Now edit the ntp.conf file so that NTP will use the TrueTime NTP reference clock driver.

EXAMPLE The following example will set up NTP on a Linux system. First, stop the power-up default, continuous, once-per-second, time-of-day message output by sending this command from your terminal program to the Præcis Cf:

ctime=off<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now send this command to change the time-of-day message format to TrueTime emulation:

emul=truetime<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now you need to make sure that the serial I/O port parameters of the Præcis Gfr are compatible with those expected by the TrueTime NTP reference clock driver: 9600, 8, N, 1. You can check the current settings by sending:

port<CR><LF>

The Præcis Gfr should respond:

9600,8,N,1<CR><LF>

If the **port** command responds with different settings, then you must change them using the **port** command with the appropriate arguments:

port=9600,8,n,1<CR><LF>

Note

If you had to change the port settings, you will now need to change the settings in your terminal program to match the new ones in order to be able to continue communicating with the Præcis Gfr.

Now turn the time-of-day message output back on:

ctime=on<CR><LF>

You should now see a time-of-day message in the TrueTime emulation format issued once-per-second:

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

The Præcis Gfr is now configured for operation with the TrueTime NTP reference clock driver.

Note

Shut down your terminal program now so that it does not interfere with the NTP reference clock driver later.

Set the Symbolic Link

Now you must define a symbolic link in your /dev directory that points to the serial I/O port to which the Præcis Gfr is connected. The name of this link is used by the NTP reference clock driver. For Linux, you might issue this shell command, where *x* is the serial device number to which your Præcis Gfr is connected:

```
ln -s /dev/ttySx /dev/true0
```

Configure NTP

Now you must edit the ntp.conf file which *ntpd*, the NTP daemon, looks for by default in the /etc directory. Add these two lines to the ntp.conf file:

```
server 127.127.5.0 prefer
fudge  127.127.5.0 refid GPS
```

The first line tells *ntpd* to use the TrueTime reference clock driver and to prefer it over all other servers which might be declared in the ntp.conf file. The trailing zero in the server address is the 'unit id' and in this case tells *ntpd* to use the device pointed to by the symbolic link true0. The second line tells *ntpd* to replace the default reference identification field for the TrueTime reference clock driver with the characters 'GPS'. This reference identification field is transmitted in the NTP server reply packets that are sent in response to NTP client request packets. It identifies the source of your NTP server's reference time.

Re-start *ntpd* to have it begin using the Præcis Gfr as the preferred synchronization peer.

Use the NTP utility *ntpq* to check that *ntpd* is able to communicate with the Præcis Gfr. After issuing the command

```
ntpq
```

you will see the ntpq command prompt:

```
ntpq>
```

Use the command

```
peers
```

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

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

Palisade NTP Setup

Setup using the Trimble Palisade emulation mode is not much more complicated than basic setup, if:

- You have been able to successfully communicate with the Præcis Gfr and know which serial I/O device on your host computer you are using.
- You have installed NTP version 4 on your host computer.

To complete the setup, these general steps will be performed. The example which follows gives the detailed step-by-step instructions.

1. Issue the command to the Præcis Gfr to set it to emulate the Trimble Palisade clock type. Then make sure that the Præcis Gfr serial I/O port parameters are compatible with the Trimble Palisade NTP reference clock driver. Refer to Chapter 1 – *Serial I/O Control and Status Commands* for detailed information on using the serial I/O port with the Præcis Gfr.
2. Now create a symbolic link in your /dev directory which points to the serial I/O port that your Præcis Gfr is connected to. The symbolic link should be called palisade0.
3. Now edit the ntp.conf file so that NTP will use the Trimble Palisade NTP reference clock driver.

EXAMPLE The following example will set up NTP on a Linux system. First, stop the power up default, continuous, once-per-second, time-of-day message output by sending this command from your terminal program to the Præcis Cf:

ctime=off<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now send this command to change the time-of-day message format to Trimble Palisade emulation:

emul=trimble<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now you need to make sure that the serial I/O port parameters of the Præcis Gfr are compatible with the Trimble Palisade NTP reference clock driver: 9600, 8, O, 1 by sending:

port<CR><LF>

The Præcis Gfr should respond:

9600,8,O,1<CR><LF>

If the **port** command responds with different settings, then you must change them using the **port** command:

port=9600,8,o,1<CR><LF>

Note

If you had to change the settings, you will now need to change the settings in your terminal program to match the new ones in order to be able to continue communicating with the Præcis Gfr.

Verify proper configuration of the emulation mode by turning the time-of-day message output back on:

ctime=on<CR><LF>

Since the Trimble Palisade uses a binary serial protocol, you will not be able to understand the characters which will be displayed by your terminal program. You need only verify that characters are being sent once each second.

Important

Now turn the time-of-day message output back off. The Palisade reference clock driver uses the RTS assertion event messages for synchronization and the continuous time-of-day messages can interfere with these.

ctime=off<CR><LF>

The Præcis Gfr is now configured for operation with the Trimble Palisade NTP reference clock driver.

> **Note**
>
> Shut down your terminal program now so that it does not interfere with the NTP reference clock driver later.

Set the Symbolic Link

Now you must define a symbolic link in your /dev directory that points to the serial I/O port to which the Præcis Gfr is connected. The name of this link is used by the NTP reference clock driver. For Linux, you might issue this shell command, where *x* is the serial device number to which your Præcis Gfr is connected:

```
ln –s /dev/ttySx /dev/palisade0
```

Configure NTP

Now you must edit the ntp.conf file which *ntpd*, the NTP daemon, looks for by default in the /etc directory. Add these lines to the ntp.conf file:

```
server 127.127.29.0 prefer
fudge  127.127.29.0 refid GPS
```

The first line tells *ntpd* to use the Palisade reference clock driver and to prefer it over all other servers. The trailing zero in the server address is the 'unit id' and in this case tells *ntpd* to use the device pointed to by the symbolic link palisade0. The second line tells *ntpd* to replace the default reference id field for the Palisade reference clock driver with the characters 'GPS'. This reference id field is transmitted in the NTP server reply packets that are sent in response to NTP client request packets. It identifies the source of your NTP server's reference time.

Re-start *ntpd* to have it begin using the Præcis Gfr as the preferred synchronization peer.

Use the NTP utility *ntpq* to check that *ntpd* is able to communicate with the Præcis Gfr. After issuing the command

`ntpq`

you will see the ntpq command prompt:

`ntpq>`

Use the command

`peers`

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

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

1PPS NTP Setup

You are ready to setup using the 1PPS driven DCD capability of the Præcis Gfr if:

- You have been able to successfully communicate with the Præcis Gfr and know which serial I/O device on your host computer you are using.
- You have installed NTP version 4 on you host computer.
- You have performed any kernel modifications and NTP recompilations that may be needed to support 1PPS driven DCD operation on your platform.
- You have performed *Basic NTP Setup* as described previously in this Chapter.

Basic NTP Setup is required because operation of the NTP with 1PPS driven DCD input measurements is always in conjunction with one of the standard NTP reference clock drivers, such as the TrueTime driver. NTP needs the time-of-day message from the NTP reference clock driver to determine the correct second for the rising edge of the next 1PPS.

Since the Præcis Gfr supports a user selectable 1PPS pulsewidth (see Chapter 1 – *Serial I/O Control and Status Commands*), you should set it to the 'NTP' value when you are using it for 1PPS driven DCD operation with NTP by issuing this command:

```
ppswidth = ntp<CR><LF>
```

In this mode, the 1PPS driven DCD pulsewidth will be set to the width of one bit at the selected baud rate of the serial I/O port, as required by the NTP reference clock drivers.

To complete the setup, it only remains to edit the ntp.conf file so that NTP will use the 1PPS kernel measurements.

Configure NTP

Having performed the setup steps in *Basic NTP Setup,* now you must edit the ntp.conf file which *ntpd*, the NTP daemon, looks for by default in the /etc directory. Find the two lines which you added previously in *Basic NTP Setup* and insert this line immediately before them:

```
pps /dev/true0 assert
```

This line tells *ntpd* to use timetags that the kernel captures on the positive transitions of the DCD line of the serial I/O port pointed to by /dev/true0. It will associate these 1PPS measurements with the reference clock driver which has the 'prefer' keyword. In this example, that would be the TrueTime reference clock driver that was setup in *Basic NTP Setup*.

Re-start *ntpd* to have it begin using the Præcis Gfr as the preferred synchronization peer with 1PPS measurement capability enabled.

Use the NTP utility *ntpq* to check that *ntpd* is able to communicate with the Præcis Gfr. After issuing the command

ntpq

you will see the ntpq command prompt:

ntpq>

Use the command

peers

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

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

Chapter

5

Setup with NTP on Windows NT 4.0

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

http://www.ntp.org

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

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

Note

Windows NT 4.0 and NTP Version 4 are *required* for operation using the Trimble Palisade emulation capabilities of the Præcis Gfr. Since this NTP reference clock driver is fairly new, your current NTP distribution may not include it. If not, you should download an up-to-date NTP distribution and install it. A pre-compiled binary executable using the Windows NT InstallShield is also freely available from Five Ten Software Group at http://www.five-ten-sg.com.

The Præcis Gfr is compatible with the only NTP reference clock driver that is currently available for NTP running under Windows NT: Trimble Palisade. This NTP reference clock driver asserts a Request To Send (RTS) on the computer's serial I/O port which is connected via the supplied cable to the Clear To Send (CTS) input of the Præcis Gfr serial I/O port. The Præcis Gfr timetags the rising edge of this CTS signal, formats the timetag and returns it in a binary message that is compatible with the Trimble Palisade NTP reference clock driver. The official NTP web site contains documentation concerning the use of the Trimble Palisade with NTP. Some of this subject matter is helpful when using the Præcis Gfr in Trimble Palisade emulation mode:

http://www.eecis.udel.edu/~mills/ntp/html/drivers/driver29.html

Note

NTP must be the only clock synchronization program running on the system. Other utilities for clock synchronization such as TimeServ, which is available in the Microsoft Windows NT Resource Kit, must be stopped, disabled or uninstalled.

Palisade NTP Setup

Setup using the Trimble Palisade emulation mode is quite simple, if:

- You have been able to successfully communicate with the Præcis Gfr and know which serial I/O device on your host computer you are using.
- You have successfully installed NTP version 4 with Trimble Palisade reference clock driver capability on your host computer.

To complete the setup, these general steps will be performed. The example which follows gives the detailed step-by-step instructions.

1. Issue the command to the Præcis Gfr to set it to emulate the Trimble Palisade clock type. Then make sure that the Præcis Gfr serial I/O port parameters are compatible with the Trimble Palisade NTP reference clock driver. Refer to Chapter 1 – *Serial I/O Control and Status Commands* for detailed information on using the serial I/O port with the Præcis Gfr.
2. Now edit the ntp.conf file so that NTP will use the Trimble Palisade NTP reference clock driver. Depending upon how you installed NTP, some of the needed configurations may have already been made to your ntp.conf.

EXAMPLE The following example will set up NTP on a Windows NT 4.0 system. First, stop the power up default, once-per-second, time-of-day message output by sending this command from your terminal program to the Præcis Cf:

ctime=off<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now send this command to change the time-of-day message format to Trimble Palisade emulation:

emul=trimble<CR><LF>

The Præcis Gfr will respond:

OK<CR><LF>

Now you need to make sure that the serial I/O port parameters of the Præcis Gfr are compatible with the Trimble Palisade NTP reference clock driver: 9600, 8, O, 1 by sending:

port<CR><LF>

The Præcis Gfr should respond:

9600,8,O,1<CR><LF>

If the **port** command responds with different settings, then you must change them using the **port** command:

port=9600,8,o,1<CR><LF>

> **Note**
>
> If you had to change the settings, you will now need to change the settings in your terminal program to match the new ones in order to be able to continue communicating with the Præcis Gfr.

Verify proper configuration of the emulation mode by turning the time-of-day message output back on:

ctime=on<CR><LF>

Since the Trimble Palisade uses a binary serial protocol, you will not be able to understand the characters which will be displayed by your terminal program. You need only verify that characters are being sent once each second.

Important

Now turn the time-of-day message output back off. The Palisade reference clock driver uses the RTS assertion event messages for synchronization and the continuous time-of-day messages can interfere with these.

ctime=off<CR><LF>

The Præcis Gfr is now configured for operation with the Trimble Palisade NTP reference clock driver.

Note

Shut down your terminal program now so that it does not interfere with the NTP reference clock driver later.

Configure NTP

Now you must edit the ntp.conf file which *ntpd.exe*, the NTP daemon, looks for by default in this directory on your system partition: \winnt\system32\drivers\etc. If your NTP installation placed this file in a different place, you must find it and edit it. Add these lines to the ntp.conf file:

```
server 127.127.29.x prefer
fudge  127.127.29.x refid GPS
```

x is the 'unit id' and identifies the specific serial I/O port to which the Præcis Gfr is connected. You must replace *x* with the COM port number that you are using. The first line tells *ntpd.exe* to use and to prefer the Palisade reference clock driver over the other servers configured in this ntp.conf file. It also tells *ntpd.exe* to expect to find a Trimble Palisade compatible reference clock connected to the serial I/O port designated as COM*x*, where *x* may be 1, 2, 3 or 4. The second line tells *ntpd.exe* to replace the default reference id field for the Palisade reference clock driver with the characters 'GPS'. This reference id field is transmitted in the NTP server reply packets that are sent in response to NTP client request packets. It identifies the source of your NTP server's reference time.

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

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

ntpq

you will see the *ntpq* command prompt:

ntpq>

Use the command

peers

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

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

Notes

Appendix A

Indicator Mode Button

The Indicator Mode Button is located behind a small hole in the rear panel of the Præcis Gfr to the left of the antenna input jack. It is accessed through this small hole using a paper clip or other small diameter, blunt tool.

Caution

Do not use an excessive amount of force in depressing the Indicator Mode Button. Damage to the switch and/or its connection to the printed circuit board could result from such excessive pressure.

The Indicator Mode Button has two functions which are described here.

Restoring Factory Default Settings

Should you wish to reset the Præcis Gfr to its factory default settings, follow this procedure:

> Press and hold in the Indicator Mode Button for at least five seconds. The Præcis Gfr will acknowledge the factory default restoration by flashing both of the LEDs together three times.

The Præcis Gfr is now reset to factory default settings. Some user settings are not affected by resetting factory defaults, these will be noted in the command descriptions.

Selecting the Indicator Mode

After power has been applied, pressing the Indicator Mode Button will toggle the Indicator Mode between the Normal and Signal Quality modes of operation. On power-up, the Præcis Gfr always defaults to the Normal Indicator Mode, which means that the current synchronization status is indicated using the green LED as described in Chapter 2, *Performing a Site Survey*.

Normal Indicator Mode

LED is On	The green LED is on continuously until a GPS signal is detected.
LED Pulses Rapidly	As the unit locks onto the GPS signal and begins to decode the timing data and phase lock the oscillator, the green LED will flash very rapidly (about a 6 Hz rate) until the data is fully decoded.
LED Pulses at 1PPS	When the unit is completely locked to UTC the green LED will pulse at precisely a 1 Hz rate, synchronized to UTC seconds, with a short on duration relative to the off duration.

Signal Quality Mode

LED is Off	The green LED is off if no GPS signal is detected.
LED is On	The green LED is on continuously once a GPS signal has been detected.
LED Pulses	Once the Præcis Gfr is locking to the GPS signal, the green LED pulses on and off at a rate that is proportional to the received signal carrier to noise ratio.

In both Normal Indicator Mode and Signal Quality Mode, the red LED is only illuminated briefly during the power-up sequence and thereafter whenever any fault condition exists. If your unit is equipped with the Alarm Output option, its behavior is the same as the red LED. That is it is in the high impedance state when the red LED is on. The nature of the fault may be determined by using the FLTSTAT serial I/O command.

Note

When the Præcis Gfr is being used in a frequency standard application with the standard TCXO oscillator, it may be more important to know the GPS signal tracking status as you are performing measurements based upon the Præcis Gfr output frequency. This is due to the holdover characteristics of the standard TCXO, which are not good enough for many precision applications. In these situations it may be desirable to operate the Præcis Gfr in the Signal Quality Mode, which gives a real-time indication of the GPS signal tracking status.

Appendix B

Upgrading the Firmware

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

What You Need To Perform the Upgrade

You will need a terminal program which supports file uploading using the XMODEM 1K protocol with CRC. This is a very common file transfer protocol and should be supported by virtually any terminal program.

Caution

You may perform the upload using any of the supported serial I/O parameter combinations, *except that 8 data bits must be used.* You must use 8 data bits because the FLASH image you will be uploading to the Præcis Gfr is in a *binary* format.

Using the higher baud rates will reduce the time needed to transfer the image file to the Præcis Gfr. The current image requires about one minute to transfer when using a baud rate of 57600.

Performing the Upgrade

Configure your terminal program and the Præcis Gfr to communicate at the desired baud rate by using the settings facility for your terminal program and the **`port`** command for the Præcis Gfr. Refer to Chapter 1 - *Serial I/O Control and Status Commands* for details on using the **`port`** command.

After establishing communications with the Præcis Gfr using the desired port settings, issue the following command to initiate the upload:

```
upload<CR><LF>
```

After issuing this command, you will see the Præcis Gfr respond with this message:

```
Waiting for download using XMODEM 1K with CRC.
Control X will abort download.
CCC...
```

You will then see the Præcis Gfr send the character 'C' every three seconds while it is waiting for you to begin uploading the image file. Should you need to abort the upload process now, send CTRL-X to the Præcis Gfr. If you abort at this time, your current firmware will remain intact. If you abort after the file transfer is in progress, you will not retain your original firmware. You will need to re-upload it.

Otherwise, start the upload using the appropriate method for your terminal program. During the upload, your terminal program will display some sort of status indication. If the upload is successful, you will see the Præcis Gfr re-boot, displaying the firmware version information when it does. Note the firmware version information at this time and verify that it is indeed the firmware that you intended to upload to the Præcis Gfr. If it is, you have successfully upgraded the firmware in your Præcis Gfr.

Problems with the Upload

Should you have difficulties with the upload 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 Præcis Gfr boot loader 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, sending the 'C' character every three seconds. You may then re-try the upload procedure, after you have corrected the original problem.

It is possible for the boot loader program to be fooled by a corrupted application program that has been previously downloaded into FLASH. In this case, it will attempt to start the application program. Generally this will result in a failure that will force a watchdog initiated re-boot. This process will be repeated indefinitely unless you intervene.

For bootloader versions 3.00 and earlier: If the boot load/application launch sequence appears to be caught in a loop, hold down the 'b' key on your keyboard while the boot loader is coming up. This will cause the boot loader to ignore the presence of what it thinks is a valid application program in FLASH and force the boot loader to initiate the XMODEM upload sequence. When you see the character 'C' being displayed every three seconds, you may initiate the upload of a new application program file.

For bootloader versions 3.01 and later: If the boot load/application launch sequence appears to be caught in a loop, type "recover" right after the bootloader versions string is displayed. This will cause the boot loader to ignore the presence of what it thinks is a valid application program in FLASH and force the boot loader to initiate the XMODEM upload sequence. When you see the character 'C' being displayed every three seconds, you may initiate the upload of a new application program file.

Notes

Appendix

C

GPS Reference Position

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

Obtaining Reference Positions

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

Using a Handheld GPS Receiver

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

Using Geodetic Databases

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

Geodesy

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

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

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

$$h = H + N$$

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

http://www.ngs.noaa.gov

http://164.214.2.59/GandG/pubs.html

WGS-84 Positions

Internally, GPS receivers perform all of their range measurement calculations using receiver and satellite positions that are kept in a Cartesian, XYZ coordinate system.

The center of the earth, as modeled by the WGS-84 ellipsoid, is the origin for the coordinates. The X-axis lies in the equatorial plane and intersects the 0° or Greenwich meridian. The Y-axis also lies in the equatorial plane and intersects the 90° east meridian. The Z-axis is perpendicular to the equatorial plane and is the polar axis. The WGS-84 ellipsoid is simple to describe mathematically and facilitates the calculations that take place in a GPS receiver to convert Cartesian XYZ coordinates to latitude, longitude and height above the WGS-84 ellipsoid.

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

Procedure

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

Having the horizontal position coordinates, you now need to determine a height above the WGS-84 ellipsoid for your location. To do that, you need to find a survey benchmark near your location and make the assumption that its height is close to your street height. From the same NGS/NOAA website, you can obtain a list of survey benchmarks that are within a user-specified radius of the NAD-83 latitude and longitude coordinates you previously determined. Of these, some are vertical control points, meaning that they have height data as well as latitude and longitude data. You can select one, or several of these that are closest to your location and download the datasheets for those benchmarks.

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

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

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 6.57
1        National Geodetic Survey,   Retrieval Date = JANUARY 23, 2002
 JT9450 ***********************************************************************
 JT9450  DESIGNATION -  B 1397
 JT9450  PID         -  JT9450
 JT9450  STATE/COUNTY-  CA/SONOMA
 JT9450  USGS QUAD   -  SANTA ROSA (1994)
 JT9450
 JT9450                        *CURRENT SURVEY CONTROL
 JT9450  ___________________________________________________________________
 JT9450* NAD 83(1986)-  38 26 44.     (N)    122 43 25.     (W)     SCALED
 JT9450* NAVD 88     -        47.270  (meters)     155.09   (feet)  ADJUSTED
 JT9450  ___________________________________________________________________
 JT9450  GEOID HEIGHT-         -31.28  (meters)                     GEOID99
 JT9450  DYNAMIC HT  -          47.241 (meters)     154.99  (feet)  COMP
 JT9450  MODELED GRAV-     980,011.6   (mgal)                       NAVD 88
 JT9450
 JT9450  VERT ORDER  -  FIRST     CLASS II
 JT9450
 JT9450.The horizontal coordinates were scaled from a topographic map and have
 JT9450.an estimated accuracy of +/- 6 seconds.
 JT9450
 JT9450.The orthometric height was determined by differential leveling
 JT9450.and adjusted by the National Geodetic Survey in June 1991.
 JT9450
 JT9450.The geoid height was determined by GEOID99.
 JT9450
 JT9450.The dynamic height is computed by dividing the NAVD 88
 JT9450.geopotential number by the normal gravity value computed on the
 JT9450.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 JT9450.degrees latitude (g = 980.6199 gals.).
 JT9450
 JT9450.The modeled gravity was interpolated from observed gravity values.
 JT9450
 JT9450;                   North         East    Units  Estimated Accuracy
 JT9450;SPC CA 2     -   586,710.    1,936,830.      MT  (+/- 180 meters Scaled)
 JT9450
 JT9450                         SUPERSEDED SURVEY CONTROL
 JT9450
 JT9450  NGVD 29     -        46.412  (m)          152.27   (f) ADJUSTED    1 2
 JT9450
 JT9450.Superseded values are not recommended for survey control.
 JT9450.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 JT9450.See file dsdata.txt to determine how the superseded data were derived.
 JT9450
 JT9450_MARKER: DB = BENCH MARK DISK
 JT9450_SETTING: 38 = ABUTMENT
 JT9450_STAMPING: B 1397 1987
 JT9450_MARK LOGO: NGS
 JT9450_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 JT9450
 JT9450  HISTORY     - Date     Condition        Report By
 JT9450  HISTORY     - 1987     MONUMENTED       NGS
 JT9450
 JT9450                         STATION DESCRIPTION
 JT9450
 JT9450'DESCRIBED BY NATIONAL GEODETIC SURVEY 1987
 JT9450'IN SANTA ROSA.
```

```
JT9450'IN SANTA ROSA, AT THE INTERSECTION OF U.S. HIGHWAY 101 AND STATE
JT9450'HIGHWAY 12, SET VERTICALLY IN THE SOUTH FACE OF THE NORTH CONCRETE
JT9450'ABUTMENT OF THE SOUTHBOUND U.S. HIGHWAY OVERPASS OF THE STATE
JT9450'HIGHWAY, 6.7 M (22.0 FT) WEST OF THE CENTER OF THE SOUTHBOUND LANES
JT9450'OF THE U.S. HIGHWAY, 5.6 M (18.4 FT) NORTH OF THE CENTERLINE OF THE
JT9450'WESTBOUND LANES OF THE STATE HIGHWAY, AND 0.3 M (1.0 FT) EAST OF THE
JT9450'WEST END OF THE ABUTMENT.
JT9450'THE MARK IS 1.4 M ABOVE A SIDEWALK.

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

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

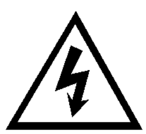
The GPS receiver actually reports a WGS-84 height of 32 meters, which gives remarkably close agreement. In general, you should not expect results that are this good. Downtown Santa Rosa is located on a very flat plain so that relatively distant survey points give acceptable results. You should exercise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

Notes

Appendix D

Lithium Battery Service/Replacement

Your Præcis Gfr incorporates a lithium battery on its IBM-PC compatible single board computer sub-system component. This battery is *not* user serviceable and your Præcis Gfr should be returned to the factory should its replacement become necessary.



CAUTION

Danger of explosion if battery is incorrectly replaced..

Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions..

Notes

Appendix

E

Time Code Formats

Your Præcis Gfr has a single time code output available at the rear panel BNC connector identified as TIMECODE OUT. The output code format is user selectable (see serial command TCODE). Each format is described below. IRIG B is the most widely used code format. 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

The IRIG B122 format contains seconds through day-of-year coded in BCD as described in the IRIG B figure below.

IRIG B123

In addition to the time information identified in B122 above, this format also contains Straight Binary Seconds of day. SBS is provided in the 17 bits shown in the IRIG B figure below with the first bit starting in position 80.

IEEE Std 1344-1995

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

NASA 36 Bit

NASA 36 bit time code is a 100 bit, pulse width modulated format containing seconds, minutes, hours and days. The format is used by several military ranges. See the NASA 36 format figure below for detailed information.

2137

The 2137 code is a pulse width modulated format containing seconds, minutes and hours. The format is used by certain security organizations. See the 2137 format figure below for detailed information.

IRIG FORMAT B:

1. Time: Universal Time (UT-2).

2. Time Frame: 1.0 second.

3. Code Digit Weighting options: BCD, SB or both.

   a. Binary Coded Decimal time-of-year **Code Word**—30 binary digits.
      (1) Seconds, minutes, hours and days.
      (2) Recycles yearly.

   b. Straight Binary time-of-day **Code Word**—17 binary digits
      (1) Seconds only.
      (2) Recycles each 24 hours.

4. **Code Word** structure:

   a. **BCD**: Word begins at **Index Count** 1. Binary coded Elements occur between **Position Identifier Elements** (7 for seconds, 7 for minutes; 6 for hours; 8 and 2 for days) until the **Code Word** is complete. An **Index Marker** occurs between decimal digits in each group to provide separation for visual resolution.

   b. **SB**: Word begins at **Index Count** 80. Five decimal digits (17 binary coded elements) occur with a **Position Identifier** between the 9th and 10th binary coded elements.

5. Least significant digit occurs first.

6. Element rates available:

   a. 100 per second (basic Element rate).
   b. 10 per second.
   c. 1 per second.

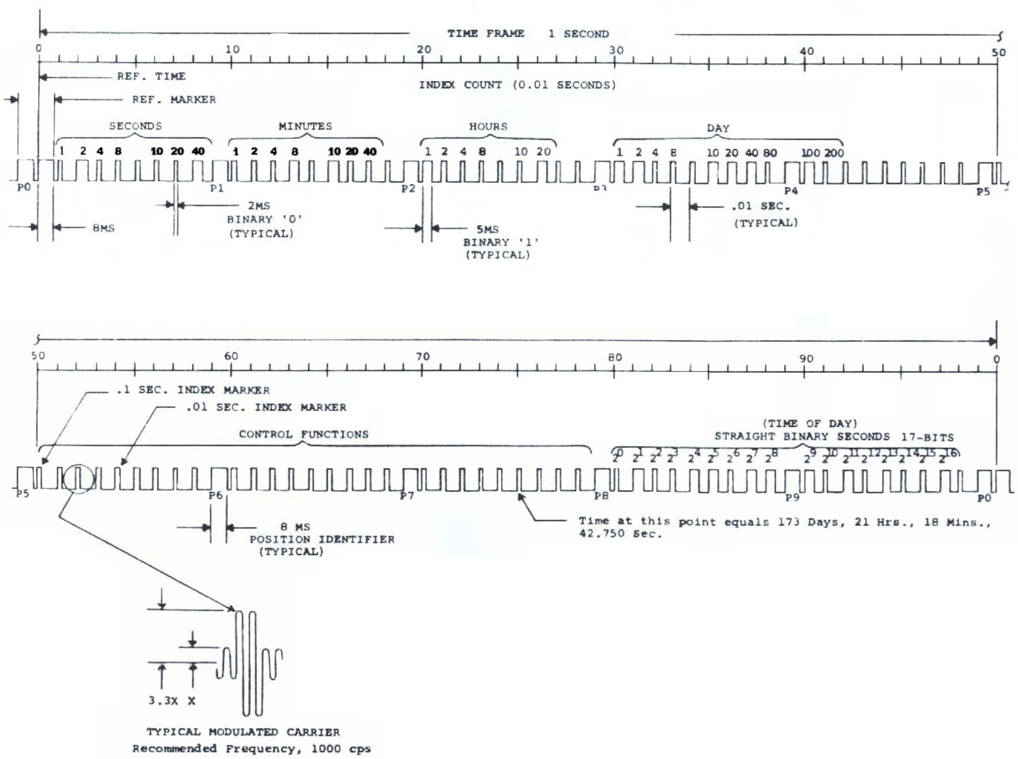
7. Element identification:

   a. "On time" reference point for all Elements is the leading edge.
   b. **Index Marker**............2 milliseconds.
      (Binary **zero** or uncoded Element).
   c. **Code Digit**............5 milliseconds.
      (Binary **one**).
   d. **Position Identifier**—10 per second............8 milliseconds.
      (Refers to the leading edge of the succeeding Element).
   e. **Reference Marker**—1 per second............Two consecutive **Position Identifiers.**

   (The "on time" point, to which the **Code Word** refers, is the leading edge of the second **Position Identifier**).

8. Resolution: 10 milliseconds (unmodulated).
   1 millisecond (modulated).

9. Carrier frequency: 1 kc. when modulated.



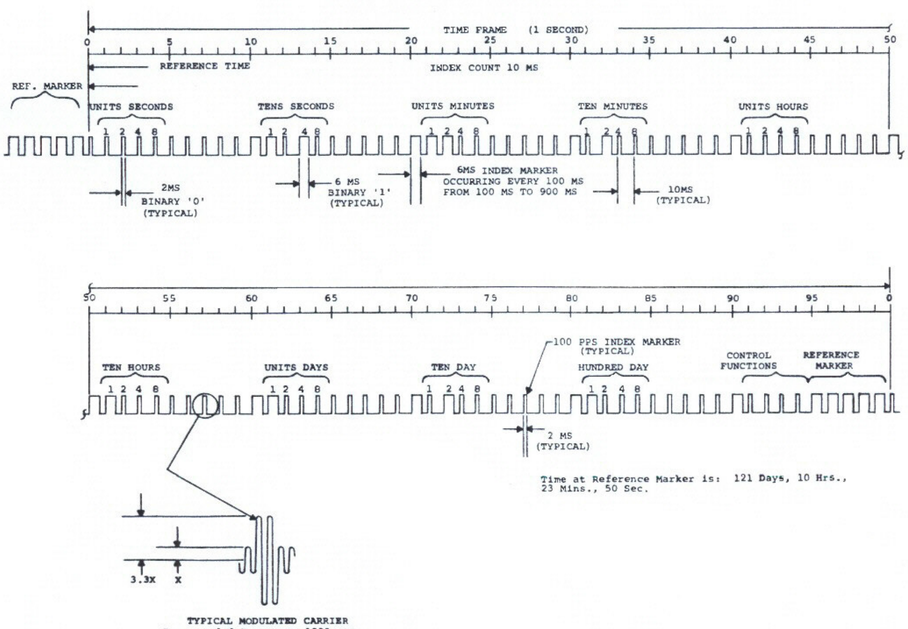
IRIG STANDARD TIME CODE—FORMAT "B" (100 pps Code) Reference IRIG Document 104-60

The **NASA 36-Bit Time Code** is a 100 pps pulse width modulated time code. This code may be used to amplitude modulate a 1000 cps sine wave carrier.

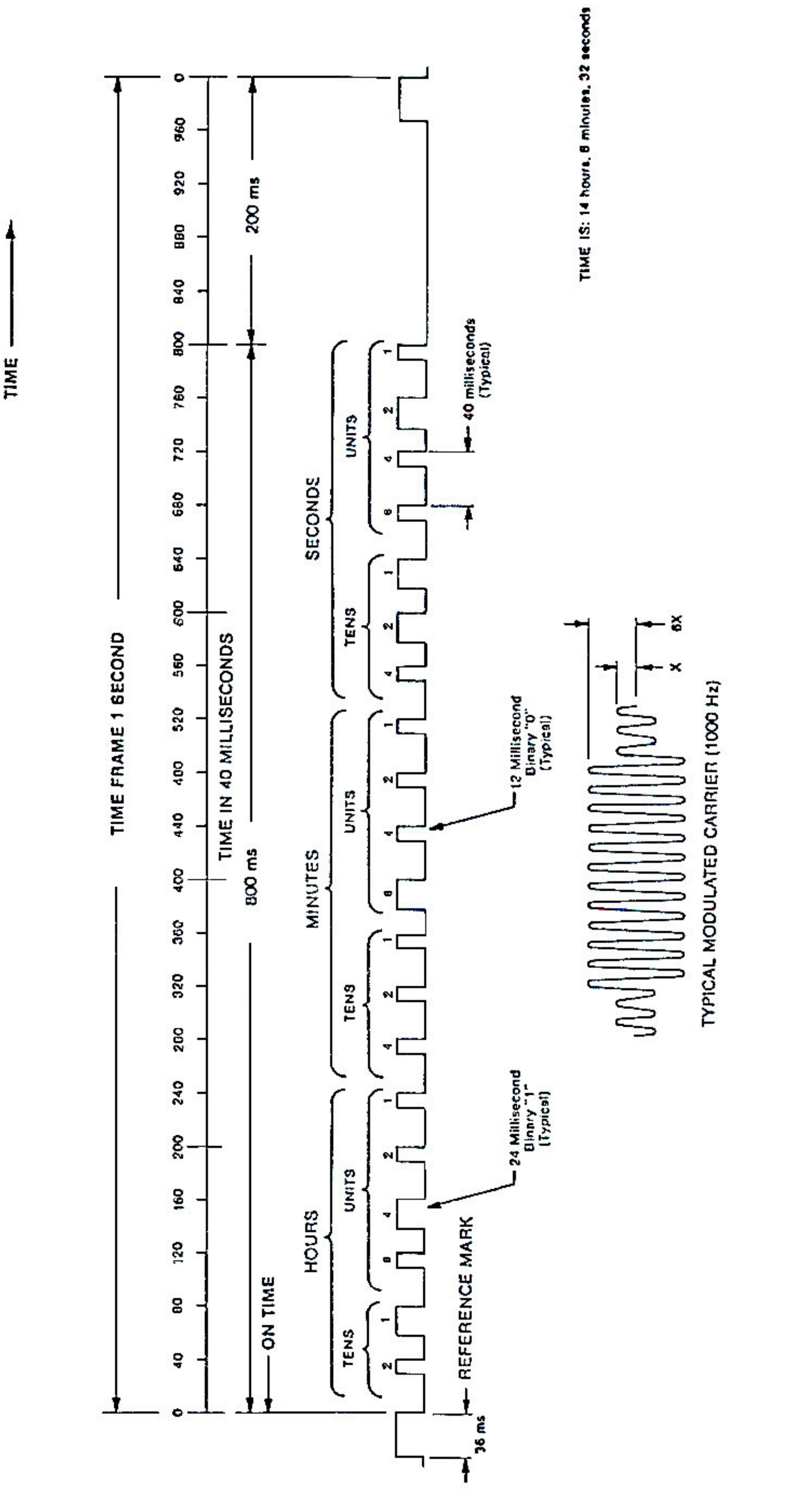
The code is composed of a **Reference Marker** and nine sub-code words, which describe time-of-year in seconds, minutes, hours and days. Each sub-code is weighted in binary-coded decimal fashion. The leading edge of all pulses are precisely spaced at 10 milliseconds intervals. The **Time Frame** is completed by 100 pps index markers and by index markers occurring every 100 milliseconds from 100 milliseconds to 900 milliseconds.

The frame **Reference Marker** is described by five binary **one's** followed by a binary **zero.** The leading edge of the binary **zero** is the reference time.

The **Time Frame** provides for the insertion of control functions for identifying the recording station.



NASA 36-BIT TIME CODE—Reference IRIG Document 104-59



25 PPS — ONE SECOND
TIME CODE
(1000 Hz - 2137)

2137 Code Format

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 Saving pending	Set to one, 1 second prior to DST change
P63	Daylight Saving	1 = Daylight Saving 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 ½ hour bit	0 = none, 1 = additional half hour time offset
P71	Time Quality binary 1	Time Quality indicates clock precision, where 4 = < 1 usec, 5 = < 10 usec, 6 = < 100 usec, 7 = < 1 msec, 8 = < 10 msec, 9 = clock unlocked
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

Notes

Appendix F

Technical Specifications

GPS Receiver:

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

Antenna:

- Integral +35 dB gain LNA with dual bandpass filters for out-of-band interference rejection
- Rugged, all-weather housing capable of operation over –40°C to +85°C temperature extremes
- Mounting via 18" long, ¾" PVC pipe with stainless steel clamps. 50' low-loss RG-59 downlead cable standard. Up to 250' optional.

Local Oscillator: TCXO.
DIP-OCXO, MS-OCXO, HS-OCXO or Rubidium (options).

Time to Lock: < 5 minutes, typical (TCXO, DIP-OCXO)
< 10 minutes, typical (MS-OCXO, HS-OCXO, Rb)

I/O Signals (on DB-9F jack)**:**

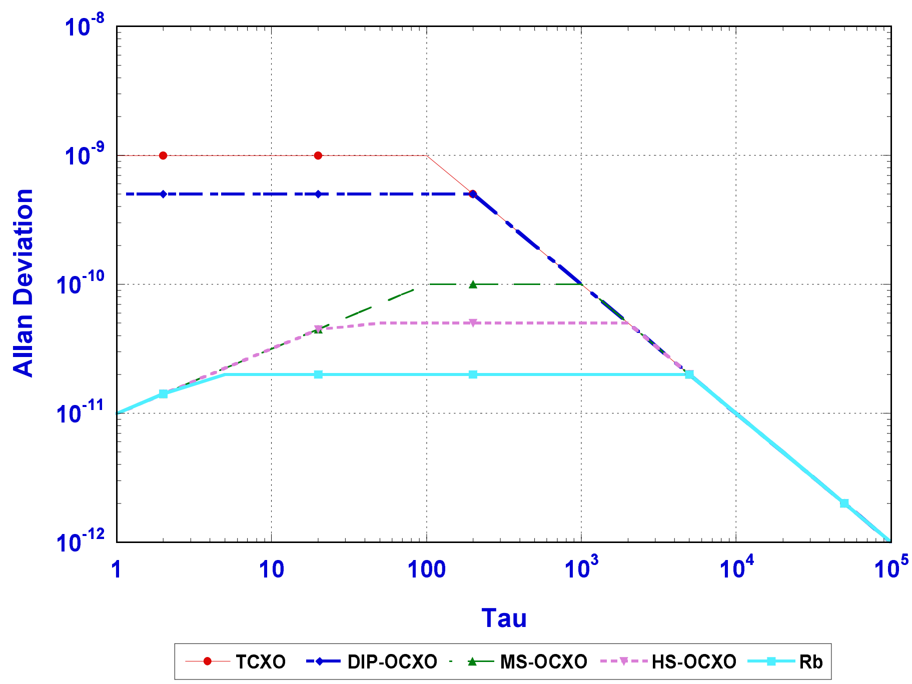
- **DCD:** output at RS-232 levels, falling edge is on-time, driven by internal 1PPS.
- **CTS:** input at RS-232 levels, positive edge transition can be captured with 32 nano-second resolution in event timetagging circuit.
- **Serial I/O:** RXD, TXD at RS-232 levels. 9600 to 57600 baud; 7 or 8 data bits; odd, even or no parity; 1 or 2 stop bits.
- **Time-of-Day:** ASCII string via serial I/O port. Seconds through years in GPS, UTC or Local Time. Depending upon the time mode selected, the UTC offset and Leap Second are determined automatically.
- 3 m. DB-9F to DB-9M cable included.

Standard Timing Outputs (rear panel BNC jacks)**:**

- **1 PPS:** 1 ms wide positive TTL pulse @ 50Ω.
  Accuracy: < 100 nanoseconds to UTC when locked
  Stability: TDEV < 50 ns, $\tau < 10^4$ seconds.
- **Time Code:** 1 vrms @ 50Ω.
  Format: user-selectable as IRIG-B122, IRIGB-123, NASA-36, 2137 or IEEE1344

Standard Frequency Output (rear panel BNC jack):

- **10 MPPS:** TTL squarewave @ 50Ω.
  Accuracy: $< 10^{-12}$ to UTC for 24 hour averaging times when locked.
  Stability:



Optional Time/Frequency Outputs (rear panel BNC jacks)**:**

- **10 MHz:** 1Vrms sinewave @ 50Ω, harmonics < -40 dBc
- **5 MHz:** 1Vrms sinewave @ 50Ω, harmonics < -40 dBc
- **1 MHz:** 1Vrms sinewave @ 50Ω, harmonics < -40 dBc
- **5 MPPS:** TTL squarewave @ 50Ω
- **1 MPPS:** TTL squarewave @ 50Ω
- **Time Code TTL:** DC-shift TTL @ 50Ω; Formats: IRIG-B, NASA-36, 2137, IEEE1344.

- **Alarm:** Open collector. Maximum pull-up voltage is 40V. Current should be limited to less than 100 mA. Is in high impedance state whenever any bit is set in the fault status word. Is in a low impedance to ground state when no faults are present.

CTS Input Event Timetagging Characteristics:

- **Accuracy:** Same as the 1PPS Timing Accuracy.
- **Resolution:** 32 ns.
- **PulseWidth:** 100 ns, minimum.
- **Re-Arm Delay:** 1 ms, i.e. the first event during any millisecond will be timetagged.
- **Buffering:** No events are buffered. Events occurring at a rate higher than 10 Hz will be discarded due to system loading and serial I/O transmission limitations.

System Status Indicators and Controls (front panel):

- **Lock LED:** green indicator that pulses to indicate the current GPS acquisition and lock status.
- **Alarm LED:** red indicator that illuminates when a serious fault condition exists.
- **Indicator Mode Button:** dual mode, restores factory defaults and selects Lock LED mode.

Power:

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

DC Power (option):

- 40-60 Vdc, 1.5A maximum.
- 3-position terminal block on rear panel: +DC IN, SAFETY GROUND, -DC IN (Floating Power Input: Either "+" or "-" can be connected to Earth Ground.)

Size:

- **Chassis:** 1.75"H x 17.0"W x 10.75"D
- **Antenna**: 2.61"H x 3.05" dia. at base.

Weight: < 5 lb. (2.70 kg.)

Environmental:

- **Temperature:** 0° to +70°C (TCXO)
  0° to +50°C (OCXO/Rubidium)
- **Humidity:** 0 to 95%, non-condensing

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 Information:

Safety:	EN 60950;1992, A1,A2: 1993, A3: 1995, A4: 1997, A11:1998
EMC:	EN 55024 (1998), EN61000-3-2 (1995 w/A1 & A2:98), EN61000-3-3 (1995 w/A1:98), EN55022 (1998 w/A1:00) Class A, VCCI (April 2000) Class A, CISPR 22 (1997) Class A, FCC Part 15 Subpart B Section 15.109 Class A, ICES-003 Class A (ANSI C63.4 1992), AS/NZS 3548 (w/A1 & A2: 97) Class A