EndRun TECHNOLOGIES
"Smarter Timing Solutions"

Præcis II

CDMA Timing Module

User Manual

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CDMA Timing Module User Manual

Preface

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

About EndRun Technologies

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

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

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

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About This Manual

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

Introduction – The Praecis II, how it works, where to use it, its main features.
Basic Installation – How to connect, configure and test your Praecis II.
Console Port – Description of the console commands for use over the serial port.

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

Warranty

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

For warranty service or repair, this product must be returned to EndRun Technologies. Buyer shall prepay shipping charges to send product to EndRun Technologies and EndRun Technologies shall pay shipping charges to return product to Buyer. However, if returned product proves to be operating normally (not defective) then Buyer shall pay for all shipping charges. If Buyer is located outside the U.S.A. then Buyer shall pay all duties and taxes, if any.

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

Limitation of Warranty

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

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

Warranty Repair

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

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

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

Repair After Warranty Expiration

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

Limitation of Liability

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

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Table of Contents

Chapter*One*

Introduction

The Praecis II is a precision source of Universal Coordinated Time (UTC) and Frequency that uses CDMA cell phone signals as its time synchronization source. For more information that is not included in this manual please visit our website: http://www.endruntechnologies.com*. There you can also download firmware upgrades, the latest manuals and other documentation.*

The Praecis II is the second generation of EndRun's Praecis product line. The Praecis II combines the features of the Praecis Ct and Praecis Cf and is backwards compatible with those first generation products while offering improved capabilities such as the ability to operate with PCS and Japanese CDMA signals. See Appendix C for detailed information on differences between the old and new Praecis.

Main Features

ASCII Time-Of-Day Message

The Praecis II provides an ASCII time-of-day message via the RS-232 serial port. The transmission of the first character in the message is "on-time" with the beginning of each second and is accurate to within one millisecond. There are several different message formats to choose from, some are compatible with existing Network Time Protocol (NTP) reference clock drivers. See ***Chapter 4 - Time-Of-Day Messages*** for information on the various formats. See ***Chapter 5 - Setup With NTP*** for information on using the time-of-day messages with reference clock drivers. See ***Appendix D - Specifications*** for information on the RS-232 serial port signals.

1PPS and 10MHz Outputs

The Praecis II provides a 1PPS (pulse-per-second) and 10 MHz output via SMA connectors. Instrumentation applications may use these signals to achieve time synchronization to typically less than 10 microseconds and frequency syntonization to less than one part in 10^{11}. See ***Chapter 2 - Basic Installation, Connecting Instruments to the Praecis II*** for more information. See ***Appendix D - Specifications*** for details on the 1PPS and 10 MHz outputs.

Event Timetagging

The Praecis II has an input available for timetagging events. The rising edge of this signal can be captured with 32 nanosecond resolution and with < 10 microseconds accuracy (typical) when the Praecis II is locked. These events are not buffered and there is a limit to how fast they can be processed. These specifications are detailed in ***Appendix D - Specifications***. The ASCII format for the time-of-day message is shown in ***Chapter 4 - Time-Of-Day Messages***. Instructions for turning the event input capability on or off is in ***Chapter 3 - Control & Status Commands***.

RS-232 Signals For Use With NTP

The Praecis II has two special signals on the serial interface that allows for 100 microsecond synchronization or better for critical computer time synchronization applications using the Network Time

Protocol (NTP). These signals are a 1PPS output on the RS-232 Data Carrier Detect (DCD) and an event input on the RS-232 Clear-To-Send (CTS), which is described above. See ***Chapter 5 - Setup With NTP*** for how to use these signals with NTP. See ***Appendix D - Specifications*** for RS-232 serial port specifications and details on the event input and the 1PPS output.

Easy Installation

Its small size and integrated antenna make installation a snap compared to competing *direct* GPS products. Once the unit is placed near the instrument or computer requiring synchronization, connected the needed signals and plug in the AC adapter. See ***Chapter 2 - Basic Installation***.

Free FLASH Upgrades

Firmware is stored in non-volatile FLASH memory, so the Praecis II can be easily upgraded in the field using the local RS-232 port. We make all firmware upgrades for our products available to our customers free of charge. See ***Appendix B - Upgrading the Firmware*** for more information.

CDMA Timing- How It Works

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

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

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

two-way communications with the base station, and be a paid subscriber to performs its function of placing and receiving calls.

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

Where to Use It

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

Chapter *Two*

Basic Installation

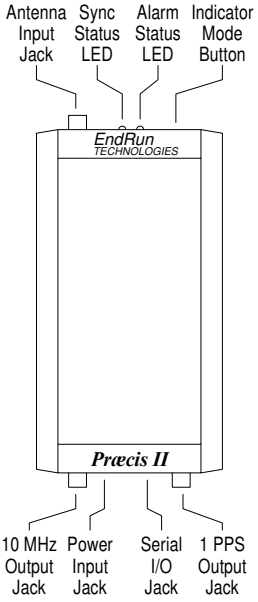
This chapter will guide you through the most basic checkout and physical installation of your Praecis II. Subsequent chapters and appendices will give you the information needed to configure your installation for the maximum performance in your operating environment.

Checking and Identifying the Hardware

Unpack and check all the items using the shipment packing list. Contact the factory if anything is missing or damaged. The Praecis II shipment typically contains (where x = variable number):

- Praecis II (part # 3002-x00x-00x)
- Praecis II User Manual (part #USM3002-0000-000) on CD (part #5102-0001-000)
- Praecis II Antenna Kit (part #0610-0011-000) consisting of:
    - Helical antenna (part #0502-0015-000)
    - Magnetic-mount antenna/cable assembly (part #0502-0007-000)
- Praecis II Accessory Kit (part #0648-0010-000) consisting of:
    - AC to 6VDC (Universal AC) Power Supply (part #0623-0002-000)
    - RJ-45 to RJ-45 CAT-5 patch cable, 2 meters (part #0501-0000-000)
    - RJ-45 to DB9F adapter (part #0501-0001-000)
    - 2 Self-adhesive velcro dots (part #0100-0055-000 and #0100-0055-001)

Praecis II Physical Description



Antenna Jack	This SMA jack connector mates with either one of the supplied antennas.
Lock LED	In Normal Mode, this green LED flashes to indicate the synchronization status. In Signal Quality Mode, it flashes to indicate the received signal quality.
Alarm LED	In Normal Mode, this red LED illuminates briefly at power-up, and thereafter whenever a serious fault condition exists. In Signal Quality Mode, it indicates the failure rate for decoding timing information from the CDMA signal.
Indicator Mode Button	The Indicator Mode Button is used for toggling between the LED Normal Mode and LED Signal Quality Mode, or for restoring factory default settings.
1PPS Output Jack	This SMA jack connector provides a 1PPS signal capable of driving 50 ohms at TTL levels.
10 MPPS Output Jack	This SMA jack connector provides a 10 MHz squarewave signal capable of driving 50 ohms at TTL levels.
RS-232 Jack	This RJ-45 connector provides the RS-232 transmit and receive signals as well as the two special timing signals needed to operate with the NTP reference clock drivers (see ***Chapter 5 - Setup with NTP***).
Power Input Jack	This 3.5 mm phone jack connector provides power.

Performing an Initial Site Survey

FCC NOTICE

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

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

1. Screw the magnetic-mount antenna cable onto the SMA antenna jack of the Praecis II. Two different antennas are shipped with the Praecis II. Try the magnetic-mount antenna first as it is better able to receive weak signals. Once you have the Praecis II working with this antenna then you may switch to the other antenna if you prefer.

2. Plug the supplied AC-to-6VDC power supply into a 115 VAC outlet.

3. Plug power input 3.5 mm phone plug into the 3.5 mm phone jack on the Praecis II.

Place the antenna on a flat, preferably metallic surface while the unit is searching for a signal. Make sure that it is not blocked by large metallic objects closer than one meter. You may hold the Praecis II in your hand or place it next to the antenna. Although the unit should normally be installed with the antenna oriented vertically, usually multipath conditions due to signal reflections indoors cause at least some of the signal to be horizontally polarized, so do not be surprised if you find that the unit will work either way. Multipath conditions can also cause another effect: signal cancellation. Since the wavelength of the signal is only about thirty centimeters, movement of the antenna just a few centimeters can sometimes cause significant signal strength changes.

Initially upon power up:

1. The unit will light the red LED for about ten seconds.

2. Then it will continuously light the green LED.

3. When the unit has detected a CDMA signal, the green LED will begin to flash very slowly (about a .4 Hz rate).

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

5. Then 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.

At this point, the unit is fully synchronized, and you may procede to permanently mounting it in the desired location.

If this sequence has not occurred within twenty minutes, you should move the unit and/or change its orientation and re-try. If you are unable to find a location where the unit will acquire the CDMA signals, you may not have *cellular* coverage in your area or the signal might be too weak in your facility. The Praecis II is shipped from the factory to search for CDMA signals in the cellular frequency band. You can use the **`channelset`** command (see ***Chapter 3 - Control and Status Commands***) to force the Praecis II to search for CDMA signals in the PCS frequency band. If you are still unable to receive signals, you should continue trying for at least a day, since CDMA base stations are taken down for service from time to time.

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

Connecting Computers to the Praecis II

Mount the Praecis II

Place the Praecis II in the previously surveyed location near the computer. Make sure that the antenna is not blocked by metallic objects that are closer than about one meter. Ideally it should be mounted vertically, as the transmitted signals are vertically polarized. When indoors, however, multipath conditions may exist. This means that reflected signals may be present with either vertical or horizontal polarization, so your unit might work in either orientation. After mounting the unit, verify that it will still acquire and track the CDMA signals.

Connect the Serial Port

1. Shutdown the computer and disconnect power from the Praecis II.

2. Connect one end of the RJ-45 CAT-5 patch cable to the RS-232 jack on the Praeis II. Connect the other end of the RJ-45 CAT-5 patch cable to the RJ-45 jack on the RJ-45 to DB9F adapter connector.

3. Connect the DB9F connector 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 ***Appendix D - Specifications*** for details on the RS-232 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 Praecis II you will need a terminal program. You must configure your terminal program to use the serial I/O port you used above. 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 Praecis II are:

- 9600 is the Baud Rate
- 8 is the Number of Data Bits
- None is the Parity
- 1 is the Number of Stop Bits

RECOMMENDED TERMINAL SETUP

Use ANSI terminal emulation mode and turn OFF handshaking.

After configuring these parameters in your terminal program, apply power to the Praecis II. Within a few seconds, your terminal program should display a sequence of boot messages similar to these:

```
Praecis II Bootloader 6010-0062-000 v 1.00 - Jun 23 2010 13:09:04
Praecis II FW 6010-0063-000 v 1.00 - Jun 25 2010 10:46:22
Praecis II FPGA 6020-0008-000 v 01
```

The first line gives the part number and version of the Praecis II bootloader firmware and the date and time of its compilation. The second line gives the part number and version of the Praecis II 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 in the native Praecis II format (EndRun format). See ***Chapter 4 - Time-of-Day Messages*** for a description of this message.

Initially, you will see that the first character in the message (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 '6', which means that the time is accurate to less than 100 microseconds 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 ***Appendix D – Specifications*** for the Praecis II RS-232 signal connections.

NOTE

It is NOT necessary to use a null-modem cable or adapter with the Praecis II.

If you are unable to find any errors in your setup, as a last resort you should restore the factory default settings to the Praecis II. It is possible that its serial port parameters are incorrect, so restoring the factory default settings will correct that. Refer to ***Chapter 6 – Indicator Mode Button*** for the procedure to restore the factory default settings.

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

Connecting Instruments to the Praecis II

The Praecis II 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. They are accessed via the two SMA jacks on the same end of the Praecis II that the RS-232 and power input jacks are located. Care should be taken not to short circuit these outputs or to connect them to other voltage sources.

If your primary application for the Praecis II is as a frequency standard, you should consider operating the LED indicators in the Signal Quality Mode. Refer to ***Chapter 6 – Indicator Mode Button*** details. In this mode, you will always know whether the Praecis II is currently locked to a CDMA signal while you are performing measurements based on its 10 MHz output frequency. The holdover accuracy of the standard TCXO will degrade to the 5×10^{-8} level fairly quickly following CDMA signal loss, depending upon the ambient temperature environment.

Chapter *Three*

Control and Status Commands

This chapter will describes the ASCII protocol supported by the Praecis II. For the RS-232 serial I/O port physical and electrical characteristics see ***Appendix D - Specifications****.*

General Serial I/O Operation

The Praecis II commands are NOT case sensitive. It 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>). The Praecis II terminates all status messages that it sends in response to commands with a <CR><LF> pair. The Praecis II does not 'echo' any user input.

The Praecis II responds to invalid commands with:

ERROR<CR><LF>
or
INVALID OPERATION<CR><LF>

At power-up with factory default settings, the Praecis II outputs a time-of-day message once-per-second. The factory default emulation mode is NONE, and the Praecis II sends the time-of-day message in its native EndRun format. See ***Chapter 4 - Time-Of-Day Messages*** for details on the various clock emulation message formats.

RECOMMENDED TERMINAL SETUP

Use ANSI terminal emulation mode and turn OFF handshaking.

Command Summary

COMMAND	FUNCTION
CAL CAL=x	With no parameter 'x' this command shows the timing calibration factor. With a parameter this command sets the timing calibration factor where x may be -0.0005 to +.0005 and + advances the timing outputs.
CHANNELSET CHANNELSET=x	With no parameter 'x' this command shows the selected CDMA receiver channel set. With a parameter this command sets the channel set where x may be A for North America Cellular, K for North America + Korea Cellular, I for India or P for North America PCS. For Japanese units the channel set cannot be altered and will always show **CHANNELSET**=J for Japan Cellular.
CTIME CTIME=x	With no parameter 'x' this command shows the status of the continuous, once-per-second output. With a parameter this command enables or disables the continuous output, where x may be ON or OFF.
DSTSTART DSTSTART=m,s,h	With no parameters this command shows the current settings for the Daylight Savings Time (DST) user override. With parameters this command will override the DST information as transmitted by the CDMA base station and use the DST info as entered where: m is month of DST start point. s is Sunday of the month of DST start point. h is hour of the transition of DST start point. **DSTSTART**=0,0,0 will disable the Daylight Savings Time user override. The time mode must be LOCALMAN in order for the Praecis II to use the **DSTSTART** information. (See **TMODE**.)

DSTSTOP DSTSTOP=m,s,h	With no parameters this command shows the current settings for the Daylight Savings Time (DST) user override. With parameters this command will override the DST information as transmitted by the CDMA base station and use the DST info as entered where: m is month of DST stop point. s is Sunday of the month of DST stop point.. h is hour of the transition of DST stop point. **DSTSTART**=0,0,0 will disable the Daylight Savings Time user override. The time mode must be LOCALMAN in order for the Praecis II to use the **DSTSTOP** information. (See **TMODE**.)
EMUL EMUL=x	With no parameter 'x' this command shows the emulation mode for the continuous, once-per-second, time-of-day output (see **CTIME**). With a parameter this command sets the emulation mode where x may be NONE, TRUETIME or TRIMBLE.
EVENT EVENT=x	With no parameter 'x' this command shows the current setting for the event timetagging function. With a parameter this command enables or disables the event timetagging function where x is ON or OFF
FLTMSG	This command shows the system fault status as human-friendly messages.
FLTSTAT	This command shows the system fault status as a machine-friendly hexadecimal code.
HELP HELP x	With no parameter 'x' this command shows a list of all available commands. With a parameter this command will show help information specific to x, where x is another command. For example: **HELP FLTMSG** will show help information specific to the **FLTMSG** command.
LEAP LEAP=c,f	With no parameters this command shows the current setting for the user-override leap second information. With parameters this command will override the leap second information as transmitted by the CDMA base station and use the leap second information as entered where: c is the current leap seconds. f is the future leap seconds. **LEAP**=0,0 will force the Praecis II to use the leap second info as transmitted by the CDMA base station.

LO LO=x	With no parameter 'x' this command shows the current local offset setting. With parameters this command will override the local offset information as transmitted by the CDMA base station and use the local offset info as entered where x is a value from -12:30 to +12:30 and + is for time zones east of Greenwich Mean Time. The seconds field must be either 0 or 30. The time mode must be LOCALMAN in order for the Praecis II to use the **LO** information. (See **TMODE**.)
OSCTYPE	Shows the installed oscillator type.
PORT PORT=b,d,p,s	With no parameters this command shows the current serial port settings. With parameters this command will set the serial port settings where: b is baud rate: 9600, 19200, 38400, 57600. d is data bits: 7 or 8. p is parity: o,e or n (for odd, even or none) s is stop bits: 1 or 2.
PPSWIDTH PPSWIDTH=x	With no parameter 'x' this command shows the current setting for the pulse width of the 1PPS Output. With a parameter this command sets the pulse width for the 1PPS Output where x is 1 to 999 (for 1 to 999 milliseconds) or NTP.
REACQUIRE	Forces the Praecis II to start over in its search for a CDMA synchronization signal.
RESET	This command will reset the unit.
RESPMODE RESPMODE=x	With no parameter 'x' this command will show the current setting for the response mode. With a parameter this command will set the respmode of the Praecis II where x is TERSE or VERBOSE.
SETTINGS	Shows a list of all user-setable commands and their current settings.
SPSTAT	Shows current status and information for the CDMA signal processor.
TIME	Shows the current time in the EndRun time message format. (See ***Chapter 4 - Time-of-Day Messages***.)

TMODE TMODE=x	With no parameter 'x' this command shows the current time mode used for calculating time. With a parameter this command will set the time mode where x is GPS, UTC, LOCAL or LOCALMAN. The time mode setting affects time information shown in the EndRun format only. Other formats are shown in UTC time mode only. (See ***Chapter 4 - Time-Of-Day Messages***.)
UPLOAD	Forces the Praecis II to begin the FLASH upload process.
VER	Shows the Praecis II firmware and FPGA versions.

Detailed Command Descriptions

CAL

This command allows you to query and set the value of a calibration offset that the Praecis II can make to the Praecis II 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 Praecis II timing outputs will be advanced in time. The Praecis II 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 CDMA base station.

In urban areas, distances to base stations should normally be less than two miles. It could make sense to set the calibration offset to perhaps + 5 microseconds, half of the approximate light speed transit time over two miles, to improve the absolute accuracy of the Praecis II. If you have some way of knowing how far the closest base station is from your site, you could make a more educated adjustment using the approximate propagation delay of one nanosecond per foot, or 3.3 nanoseconds per meter and the **CAL** command. Set value is retained in non-volatile FLASH memory.

Query:	**CAL<CR><LF>**
Praecis II response:	**-.000123452<CR><LF>**
Set:	**CAL=.00015<CR><LF>**
Praecis II response:	**OK<CR><LF>**
Factory Default Setting:	**0**

Numerical inputs are accepted in any standard format for this command. For example, you may enter 1.5e-4 for the number 0.00015.

CHANNELSET

This command allows you to set the frequency channels that the CDMA receiver searches in order to find a timing signal. Most users will not need to use this command as the default setting is for the North American Cellular frequency channel set. There are four allowable entries: A for North Amer-

ica Cellular, P for North America PCS, K for Korea, and I for India Cellular. Set value is retained in non-volatile FLASH memory. PCS, Korean and Indian users will need to change the default setting as below:

Query:	**CHANNELSET<CR><LF>**
Praecis II response:	**NORTH AMERICA<CR><LF>**
Set:	**CHANNELSET=P<CR><LF>**
Praecis II response:	**OK<CR><LF>**

Factory Default Setting: **NORTH AMERICA**

This is the setting as shipped by the factory but will not be affected by resetting factory defaults using the Indicator Mode Button (see ***Chapter 6 - Indicator Mode Button and LEDs***). Once you modify this setting it will stay that way.

CTIME

This command allows you 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.

Query:	**CTIME<CR><LF>**
Praecis II response:	**off<CR><LF>**
Set:	**CTIME=on<CR><LF>**
Praecis II 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 you to query and set the start time for the Daylight Savings Time transition. This setting is used to compute Local Time if **TMODE** = LOCALMAN (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 second Sunday in March 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.

Query:	**DSTSTART<CR><LF>**
Praecis II response:	**4,1,2<CR><LF>**

Set: **DSTSTART=4,1,2<CR><LF>**
Praecis II response: **OK<CR><LF>**

Factory Default Setting: 0,0,0

DSTSTOP

This command allows you to query and set the stop time for the Daylight Savings Time transition. This setting is used to compute Local Time if **TMODE** = LOCALMAN (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 first Sunday in November 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.

Query: **DSTSTOP<CR><LF>**
Praecis II response: **10,L,2<CR><LF>**

Set: **DSTSTOP=10,L,2<CR><LF>**
Praecis II response: **OK<CR><LF>**

Factory Default Setting: 0,0,0

EMUL

This command allows you 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, TRIMBLE and TRUETIME. Set value is retained in non-volatile FLASH memory. See ***Chapter 4 - Time-Of-Day Messages*** for details.

Query: **EMUL<CR><LF>**
Praecis II response: **NONE<CR><LF>**

Set: **EMUL=trimble<CR><LF>**
Praecis II response: **OK<CR><LF>**

Factory Default Setting: NONE

EVENT

This command allows you 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 any attempt to change this using the **EVENT** command will be ignored. If **CTIME** is ON, its output takes priority over these event timetags. It is recommend-

ed that **CTIME** be turned OFF during event timetagging operation. Refer to ***Appendix D – Specifications*** for event input details.

Query:	**EVENT<CR><LF>**
Praecis II response:	**OFF<CR><LF>**
Set:	**EVENT=on<CR><LF>**
Praecis II response:	**OK<CR><LF>**

Then an Event time message will be sent following each rising edge 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 ***Chapter 4 - Time-Of-Day Messages*** for details on the EndRun time message format.

Factory Default Setting: **OFF**

FLTMSG

This query-only command displays the current fault status of the Praecis II as one or more human-friendly messages. When operating in the Normal LED Mode (see ***Chapter 6 - Indicator Mode Button and LEDs***) then any fault condition will also illuminate the red LED. For more detailed information on each fault see the fault descriptions in **FLTSTAT** below.

Query:	**FLTMSG<CR><LF>**
Praecis II response:	**No faults.** or **CDMA synchronization signal not found.**

FLTSTAT

This query-only command displays the current fault status of the Praecis II. The fault status is shown as contained in sixteen bits which are displayed in four hexadecimal characters. Each bit of each hexadecimal character indicates the status of a Praecis II component. When operating in the Normal Mode (see ***Chapter 6 – Indicator Mode Button and LEDs***), then any fault condition will also illuminate the red LED.

Hex Char	Bit 3	Bit 2	Bit 1	Bit 0
0	FLASH Write Fault	FPGA Config Fault	No Signal Time-Out	DAC Control Over-Range
1	Main Osc Failure	Time Input Fault	Local Osc Failure	Local Osc PLL Fault
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 oscillator has reached either the high (55000) or low (10000) limit while locked to the CDMA sig-

nal. Unless the unit is being subjected to out-of-specification environmental conditions, this would indicate that the oscillator frequency has drifted near to the end of life region. This should normally only occur after about ten years of operation. The unit will continue to function until the oscillator frequency finally reaches one of the actual DAC endpoints. The unit should be returned to the factory for oscillator replacement at the customer's convenience.

No Signal Time-Out: This bit indicates that the unit has not been able to acquire a CDMA signal for one hour while the Time Figure-of-Merit has been 9 (see ***Appendix A - TFOM***). 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 a base station outage or antenna failure. If the condition persists indefinitely, and a problem with the antenna is not evident, the unit may need to be returned to the factory for repair.

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

FLASH Write Fault: This bit indicates that the microprocessor was unable to verify a write to the FLASH non-volatile parameter storage area. This should not occur under normal operation. The unit should be returned to the factory for repair.

Local Oscillator PLL Fault: This bit indicates that the local oscillator phase-locked-loop (PLL) synthesizer is unlocked. This condition should not normally occur unless the unit is subjected to out-of-specification environmental conditions. Otherwise, this would be a fatal fault and the unit should be returned to the factory for repair.

Local Oscillator Failure: This bit indicates that the local oscillator phase-locked-loop (PLL) synthesizer has failed. This condition should not normally occur unless the unit is subjected to out-of-specification environmental conditions. Otherwise, this would be a fatal fault and the unit should be returned to the factory for repair.

Time Input Fault: This bit indicates that the microprocessor received an erroneous time input from the CDMA engine. If the condition persists please report it to the factory.

Main Oscillator Failure: This bit indicates that the main oscillator has failed. This condition should not normally occur unless the unit is subjected to out-of-specification environmental conditions. Otherwise, this would be a fatal fault and the unit should be returned to the factory for repair.

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

Query:	**FLTSTAT<CR><LF>**
Praecis II response:	**0x001A<CR><LF>**

HELP

This query-only command displays a menu of the available status and control commands supported by the Praecis II, along with the syntax of their usage. Command-specific help is also available:

Query:	**HELP<CR><LF>**
Praecis II response:	Full menu of available commands is displayed.

Query:	**HELP LEAP<CR><LF>**
Praecis II response:	Information related to the **LEAP** command is displayed.

LEAP

This command allows the user to set the current and future leap seconds. Set value is retained in non-volatile FLASH memory. The CDMA mobile phone system does provide a mechanism for automatic UTC leap second insertion. However, there are some locations where this has not been implemented to the precision needed for a smooth leap second transition. This command overrides the UTC leap second information received from the CDMA base station. In so doing, your Praecis II will properly perform a leap second transition at UTC midnight.

Leap seconds are inserted at UTC midnight on June 30 or December 31 only. If there is no leap second pending at the next transition point then enter the command with current=future. If there is a leap second pending then enter the command with current=future+1. The EndRun Technologies website maintains a page devoted to notifying users of the appropriate current and future leap second values at:

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

Query:	**LEAP<CR><LF>**
Praecis II response:	**0 0<CR><LF>**

Set:	**LEAP=15,15**
Praecis II response:	**OK**

Factory Default Setting:	**Current and future leap seconds as of the date your Praecis II ships from the factory.**

Since the Praecis II is shipped from the factory with the proper leap second information you need take no action with this command until the next leap second transition. They occur about every 2-3 years. Refer to the webpage above for information on the next leap second.

Once you modify this setting it will stay that way regardless of whether you reset factory defaults using the Indicator Mode Button (see ***Chapter 6 - Indicator Mode Button and LEDs***).

To force the Praecis II to automatically receive leap second information from the CDMA base station set **LEAP**=0,0. This is not recommended but may be useful for some applications.

LO

This command allows the you to set or query the local offset setting. This setting is used to compute Local Time if **TMODE** = LOCALMAN (see **TMODE** command). The values entered can range from -12:30 to +12:30. Positive values indicate a time zone east of Greenwich Mean Time. The minutes field must be either 00 or 30. Set value is retained in non-volatile FLASH memory.

Query: `LO<CR><LF>`
Praeecis II response: `-7:00<CR><LF>`

Set: `LO=+12:30<cr><lf>`
Praecis II response: `OK<CR><LF>`

Factory Default Setting: **+0:00**

OSCTYPE

This command allows you to query the oscillator type for this unit. This value is set at the factory and cannot be changed because it depends on the hardware configuration of your Praecis II.

Query: `OSCTYPE<CR><LF>`
Praecis II response: `TCXO<CR><LF>`

PORT

This command allows you 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 Praecis II. *Restoring the factory default settings may be necessary should you forget the current settings*. See ***Chapter 6 – Indicator Mode Button and LEDs*** 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.

Query: `PORT<CR><LF>`
Praecis II response: `9600,8,N,1<CR><LF>`

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

Factory Default Setting: **9600, 8, N, 1**

PPSWIDTH

This command allows you 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. (See ***Chapter 5 - Setup with NTP*** for more information on `PPSWIDTH`=NTP.)

Query: `PPSWIDTH<CR><LF>`
Praecis II response: `1<CR><LF>`

Set: **PPSWIDTH=500<CR><LF>**
Praecis II response: **OK<CR><LF>**

Factory Default Setting: **1**

REACQUIRE

With this command you can force the CDMA receiver to start over in its search for a valid CDMA signal. This is generally only used for debugging

Command: **REACQUIRE<CR><LF>**
Praecis II response: **OK<CR><LF>**

RESET

This command allows you to perform a software reset of the unit.

Command: **RESET<CR><LF>**
Praecis II response: **OK**

RESPMODE

This command allows you 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**.

Query: **RESPMODE<CR><LF>**
Praecis II response: **RESPMODE = VERBOSE<CR><LF>**
or
TERSE<CR><LF>

Set: **RESPMODE=TERSE<CR><LF>**
Praecis II 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.

Query: **SETTINGS<CR><LF>**

Praecis II response:

```
Cal = 0.000000000<CR><LF>
Channelset = NORTH AMERICA CELLULAR<CR><LF>
Ctime = OFF<CR><LF>
DSTStart = 0,0,0<CR><LF>
DSTStop=0,0,0<CR><LF>
Emul = NONE<CR><LF>
Event = OFF<CR><LF>
Leap = 15, 15<CR><LF>
Lo = +0:00<CR><LF>
Port = 57600,8,N,1<CR><LF>
PPSwidth = 1<CR><LF>
Respmode = TERSE<CR><LF>
Tmode = UTC<CR><LF>
```

SPSTAT

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

SPS CHAN PNO AGC VCDAC SN.R F.ERR<CR><LF>

Where:

SPS is the Signal Processor State, one of ACQ (Acquiring), DET (Signal Detected), LKG (Code Locking), TKG (Carrier Locking), LKD (Locked).

CHAN is the CDMA frequency channel being used. For North American frequencies the reported channel will be: PRIA, PRIB, SECA, or SECB. These stand for Primary A, Primary B, Secondary A or Secondary B channels. For Korean frequencies the reported channel will be: PRKA, PRKB, SEKA, or SEKB. These stand for Primary A, Primary B, Secondary A or Secondary B channels. For Indian frequencies the reported channel will be: 185I, 226I, 267I, 308I, 369I, 410I, 451I, or 492I. There are multiple primary and secondary channels in the Indian channelset so the channel number is being used.

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

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

VCDAC is the TCXO Voltage Control DAC word, 0 to 65535 with larger numbers implying higher TCXO frequency. Typical range is 20000 to 38000.

SN.R is the carrier Signal to Noise Ratio, 0.00 to 99.9, measured in the Sync Channel symbol rate bandwidth. Typical range is 2.5 to 11.0.

F.ERR is the Sync Channel Frame Error Rate, 0.000 to 1.000, with a higher number implying more Cyclical Redundancy Check failures when processing the Sync Channel message frames. Higher numbers will correlate with lower Signal to Noise Ratios.

Query: **SPSTAT<CR><LF>**
Praecis II response: **LKD PRIB 132 161 28495 6.9 0.000<CR><LF>**

TIME

This query-only command displays the current time-of-day in the EndRun format. See ***Chapter 4 - Time-Of-Day Messages*** for details about this format. 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. The leap seconds fields show that 15 leap seconds is the value for both current and future leap seconds. This means there is no leap second pending.

Query: **TIME<CR><LF>**
Praecis II response: **6 2000 155 13:45:01 +23 L 15 15<CR><LF>**

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 Trimble or TrueTime clock types. They are always sent in UTC time.** The time mode setting affects the time-of-day messages that are in the EndRun format only. There are four available time modes:

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, 15 leap seconds have been applied to UTC since the GPS epoch, so GPS time is currently 15 seconds ahead of UTC time.

UTC The UTC setting will cause the time-of-day to be displayed as UTC time. UTC time is GPS time with the addition of leap seconds. Leap seconds can be determined by the unit automatically from data contained in the CDMA signal. Leap seconds can also be determined manually, via the user interface (refer to the **LEAP** command).

LOCAL The LOCAL setting will cause the time-of-day to be displayed with the local time zone offset to UTC. The local time zone offset and daylight savings time transition is determined automatically from data contained in the CDMA signal.

LOCALMAN The LOCALMAN setting will cause the time-of-day to be displayed with the local time zone offset to UTC. The local time zone offset is determined manually, via the user interface (refer to the **LO**, **DSTSTART** and **DSTSTOP** commands).

Query: **TMODE<CR><LF>**
Praecis II response: **GPS<CR><LF>**

Set: **TMODE=LOCAL<CR><LF>**
Praecis II response: **OK<CR><LF>**

Factory Default Setting: **UTC**

UPLOAD

This command allows you to upload a new program to the FLASH memory of the Praecis II. Refer to ***Appendix B – Upgrading the Firmware*** for detailed instructions for performing the **UPLOAD** procedure.

Command: **UPLOAD<CR><LF>**

Praecis II 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.

VER

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

Query: **VER<CR><LF>**

Praecis II response:

Praecis II FW 6010-0063-000 v 1.00 - Jun 25 2010 10:46:22
FPGA 6020-0008-000 v 01<CR><LF>

Chapter *Four*

Time-Of-Day Messages

This chapter describes the format of the native Praecis II time message, called the EndRun format, plus the various formats used in emulating TrueTime and Trimble time messages.

EndRun Format

TIME

The EndRun format is used for showing time-of-day information when using the **TIME** command or for the continuous, once-per-second output when **EMUL**=NONE and **CTIME**=ON. See ***Chapter 3 - Control and Status Commands*** for information on **TIME**, **EMUL** and **CTIME**. This format is described below:

```
T YYYY DDD HH:DD:SS zZZ m CC FF<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

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,
zZZ is the time zone (or local) offset (in units of half-hours) and is non-zero only when the time mode is LOCAL or LOCALMAN..
m is the Time Mode character and is one of:
- G = GPS,
- L = LOCAL or LOCALMAN,
- U = UTC

CC is the current leap seconds.
FF is the future leap seconds. If a leap second is pending, this value will match the current leap seconds value until it is within 24 hours of the transition. Within 24 hours of a leap second transition it will show the actual future leap seconds value.
<CR><LF>is an ASCII carriage return (CTRL-M, 0x0D) and line feed (CTRL-J, 0x0A).

When this message is received in response to the **TIME** command it will show the exact time at the point when the Praecis II receives **TIME**<CR><LF>.

When this message is received in the continuous, once-per-second time-of-day output the ‘T’ at the beginning of the message is the “on-time” character. This means that this character is transmitted at the beginning of each second, within 1 millisecond of the second roll-over.

EVENT

This version of the EndRun format is used for showing time-of-day information when using the event input capability. This time-of-day message shows the exact time of the receipt of an when an event signal occurs. See ***Chapter 3 - Control and Status Commands*** for information on the **`EVENT`** command. See ***Appendix D - Specifications*** for details on the event input signal.

The only difference between this and the previous EndRun format is the addition of sub-seconds information:

```
T YYYY DDD HH:DD:SS.sssssssss zZZ m CC FF<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

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,
.sssssssss is the sub-seconds information.
zZZ is the time zone (or local) offset (in units of half-hours) and is non-zero only when the time mode is LOCAL or LOCALMAN..
m is the Time Mode character and is one of:
- G = GPS,
- L = LOCAL or LOCALMAN,
- U = UTC

CC is the current leap seconds.
FF is the future leap seconds. If a leap second is pending, this value will match the current leap seconds value until it is within 24 hours of the transition. Within 24 hours of a leap second transition it will show the actual future leap seconds value.
<CR><LF>is an ASCII carriage return (CTRL-M, 0x0D) and line feed (CTRL-J, 0x0A).

Clock Emulation Modes

The following formats are used only for the continuous, once-per-second, time-of-day output. Use the **EMUL** command to select the various formats. If **EMUL=NONE**,then the EndRun format will be used (see above). Use the **CTIME** command to turn the continuous time output ON or OFF.

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)

<CR><LF>is an ASCII carriage return (CTRL-M, 0x0D) and line feed (CTRL-J, 0x0A).

Trimble

This format is only useful in conjunction with the Trimble Palisade NTP reference clock driver as it is not human readable. (See ***Chapter 5 - Setup with NTP*** for more information.) It is sent in Trimble Standard Interface Protocol (TSIP) using a binary packet format: *Primary NTP Pkt 8F-AD*. The Event Timetag function is forced to ON(TRIMBLE) and any attempt to change this using the **EVENT** command will be ignored. The Praecis II will send packets at every event occurrence on the RS-232 CTS assertion events and will also send once-per-second packets if **CTIME**=ON. (*It is recommended that* **CTIME***=OFF when using this emulation mode.)* These packets contain a timestamp with 32 nanosecond resolution. *The time information in this message is always UTC, regardless of what the time mode is (see* **TMODE***).*

Byte 18, Receiver Status of NTP Pkt 8F-AD contains the synchronization status information. The Praecis II 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

Chapter*Five*

Setup with NTP

This chapter describes the basic procedure for setting up the Praecis II to work with various Network Time Protocol (NTP) reference clock drivers on Unix-like platforms.

Overview

To configure your Unix-like computer to use your Praecis II, you must have successfully completed the installation procedures in ***Chapter 2 - Basic Installation***. This manual is not a 'How-To' on installing and using NTP. Basic approaches to NTP configuration for operation with the Praecis II 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 priviledges 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 instructions given here assume that you are using NTP Version 4. Version 4 is required for operation using the Trimble Palisade emulation capabilities of the Praecis II. If you are planning to use the 1PPS capabilities of the Praecis II, 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 Praecis II serial I/O connector:

Data Carrier Detect (DCD) The Praecis II drives this signal from its 1PPS output. The falling edge of the DCD output from the Praecis II is on-time, and the negative pulse width is set to one bit width at the selected baud rate.

Clear To Send (CTS) The Praecis II 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 Praecis II serial I/O port. When configured for Trimble Palisade emulation mode, the Praecis II 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 Praecis II when it is operating in Trimble Palisade emulation mode:

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

Three methods of using the Praecis II 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 Praecis II. 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 Praecis II. 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 Praecis II. 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 Praecis II and know which serial I/O device on your host computer you are using.

• You have installed NTP version 4 on your host computer and the Truetime reference clock driver is compiled into the ntp daemon.

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 Praecis II to set it to emulate the TrueTime clock type. Then make sure that the Praecis II serial I/O port parameters are compatible with the TrueTime NTP reference clock driver. Refer to ***Chapter 3 – Control and Status Commands*** for detailed information on using the serial I/O port with the Praecis II.

2. Next, create a symbolic link in your /dev directory which points to the serial I/O port to which your Praecis II is connected. The symbolic link must be called true0, when you are using the TrueTime NTP reference clock driver.

3. Finally, 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 Praecis II:

`ctime=off<CR><LF>`

The Praecis II 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 Praecis II will respond: **`OK<CR><LF>`**

Now you need to make sure that the serial I/O port parameters of the Praecis II 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 Praecis II should respond: **`9600,8,N,1<CR><LF>`**

If the PORT command responds with different settings, then you must change them using 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 Praecis II.

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 Praecis II 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 Praecis II 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 Praecis II 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 the /etc directory. Add these two lines to the ntp.conf file:

```
server 127.127.5.0 prefer
fudge  127.127.5.0 refid CDMA
```

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 'CDMA'. 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 Praecis II as the preferred synchronization peer.

Use the NTP utility *ntpq* to check that *ntpd* is able to communicate with the Praecis II. 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 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 Praecis II and know which serial I/O device on your host computer you are using.

- You have installed NTP version 4 on your host computer and the Trimble Palisade reference clock driver is compiled into the ntp daemon.

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 Praecis II to set it to emulate the Trimble Palisade clock type. Then make sure that the Praecis II serial I/O port parameters are compatible with the Trimble Palisade NTP reference clock driver. Refer to ***Chapter 3 – Control and Status Commands*** for detailed information on using the serial I/O port with the Praecis II.

2. Now create a symbolic link in your /dev directory which points to the serial I/O port that your Praecis II 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 Praecis II:

ctime=off<CR><LF>

The Praecis II 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 Praecis II will respond:

OK<CR><LF>

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

port<CR><LF>

The Praecis II 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>

The Praecis II 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 Praecis II 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 Praecis II 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 the /etc directory. Add these lines to the ntp.conf file:

```
server 127.127.29.0 prefer
fudge  127.127.29.0 refid CDMA
```

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 'CDMA'. 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 Praecis II as the preferred synchronization peer.

Use the NTP utility *ntpq* to check that *ntpd* is able to communicate with the Praecis II. 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 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 Praecis II if:

• You have been able to successfully communicate with the Praecis II and know which serial I/O device on your host computer you are using.

• You have installed an up-to-date NTP version 4 on your host computer and the Truetime reference clock driver is compiled into the NTP daemon. You must also have the Atom reference clock driver compiled into the daemon. For Linux, you must have the PPS-related header include files present on your system in order to compile the NTP daemon with the Atom reference clock driver. As of this writing, kernel version 3.2.2 does not natively contain the *timepps.h* file.

• You have performed any kernel modifications and recompilations that may be needed to support 1PPS-driven DCD operation on your platform. If you are on the Linux platform, kernel versions 2.6.38 and higher now have PPS support as a compile option for the standard kernel available from www.kernel.org. Under Linux, you will also need the *ldattach* utility. It must be a recent enough version to support the PPS line discipline. Type **`ldattach`** with no command line arguments to see a list of supported line disciplines.

• 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 Praecis II supports a user selectable 1PPS pulsewidth (see ***Chapter 3 – 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.

On Linux platforms, you must load the PPS kernel modules:

```
modprobe pps_core pps_ldisc
```

and you must start the *ldattach* daemon:

```
ldattach PPS /dev/true0
```

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 these lines immediately after them:

```
server 127.127.22.0 minpoll 4 maxpoll 4
fudge 127.127.22.0 flag2 1 flag3 1
```

These lines tell *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***.

Restart *ntpd* to have it begin using the Praecis II 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 Praecis II. 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 it is being 'reached'. (You may have to continue issuing the peers command for a minute or two before you will see the 'reach' count increment.) You should also see the PPS refclock in the peer list. If you have other peers configured, verify that the offset information for the TrueTime and PPS peers 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*Six*

Indicator Mode Button and LEDs

This chapter describes the Indicator Mode Button and its two functions. One function is to restore factory default settings for all parameters. The other function is to toggle between two operating modes for the LEDs, called the Normal Indicator Mode and the Signal Quality Indicator Mode.

The Indicator Mode Button is located on the same end plate of the Praecis II where the antenna input jack and indicator LEDs are mounted. It is accessed through a small hole in the endplate to the left of the LEDs. A paper clip or other small diameter, blunt tool is a good way to gently depress the button.

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.

Restoring Factory Default Settings

Should you wish to reset the Praecis II to its factory default settings, follow this procedure:

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

All command settings are now reset to factory default settings. (See ***Chapter 3 - Control and Status Commands*** for the factory default setting for each command.) Some command settings (**`CHANNELSET`** and **`LEAP`**) are not affected by resetting factory defaults.

Indicator Mode Selection

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 Praecis II is always in the Normal Indicator Mode, which means that the current synchronization status is indicated using the green LED as described in ***Chapter 2 - Basic Installation, Performing a Site Survey***.

Normal Indicator Mode

Green LED	FUNCTION
On	The green LED is on continuously until a CDMA signal is detected.
Pulses Slowly	When the unit has detected a CDMA signal, the green LED will begin to flash very slowly (about a .4 Hz rate).
Pulses Rapidly	As the unit locks onto the CDMA signal and begins to decode the timing data, the green LED will flash very rapidly (about a 6 Hz rate) until the data is fully decoded.
Pulses at One-Pulse-Per-Second	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.

In Normal Indicator Mode, the red LED is only illuminated briefly during the power-up sequence and thereafter whenever any fault condition exists. The nature of the fault may be determined by using the FLTSTAT serial I/O command.

Signal Quality Indicator Mode

Green LED	FUNCTION
Off	The LED is off until a CDMA signal is detected.
On	The LED is on continuously once a CDMA signal has been detected.
Pulses	Once the Praecis II begins to lock to the CDMA signal, the green LED pulses on and off at a rate that is proportional to the received signal carrier-to-noise ratio. A faster pulse rate means the signal is stronger. This can be helpful in finding good locations for permanently mounting the Praecis II.

In Signal Quality Indicator Mode, the red LED is turned on to indicate that either no Sync Channel data is available or that a Cyclical Redundancy Check (CRC) failure has occurred in decoding the Sync Channel data from the CDMA signal. In general, poor carrier-to-noise ratios, as indicated by a slowly flashing green LED, will result in a higher incidence of CRC failures, as indicated by a larger ratio of red LED on-time to off-time.

NOTE

In general, it is advisable to return the Praecis II to the Normal Indicator Mode when you have finished your site selection and installation. Otherwise you may not be able to verify that your Praecis II is operating properly by simple observation of the red LED.

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

Appendix *A*

Time Figure-of-Merit (TFOM)

This appendix describes the Time Figure of Merit (TFOM) number. The EndRun time-of-day message sent by the Praecis II contains a character that indicates the level of accuracy that should be included in the interpretation of the time-of-day contained in the message. This is called the TFOM and ranges from 6 to 9:

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

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

Due to this extrapolation behavior, brief removal of the antenna from a normally operating Praecis II II will not induce an immediate alarm condition. If the antenna is removed for long enough periods, you should see the TFOM character change to indicate a gradually deteriorating accuracy of the timing outputs. If the signal loss condition persists longer, then the final, unsynchronized state will eventually be reached. If the Praecis II is unable to achieve re-synchronization within one hour after reaching this state, the red LED will illuminate. Queries using the **`FLTSTAT`** or **`FLTMSG`** commands (see ***Chapter 4 - Control and Status Commands***) will indicate a loss-of-signal time-out condition.

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 Praecis II.

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 Praecis II is in a binary format.

Using the higher baud rates will reduce the time needed to transfer the image file to the Praecis II. 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 Praecis II to communicate at the desired baud rate by using the settings facility for your terminal program and the **`port`** command for the Praecis II. Refer to ***Chapter 3 - Control and Status Commands*** for details on using the **`port`** command.

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

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

After issuing this command, you will see the Praecis II respond with this message:

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

You will then see the Praecis II 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 Praecis II. 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 Praecis II reboot, 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. If it is, you have successfully upgraded the firmware in your Praecis II.

Problems With The Upgrade

Should you have difficulties with the upgrade due to a corrupt file, power failure during upload, or other accident, do not be alarmed. Even though you may have lost the existing application program, the Praecis II bootloader program will remain intact. On boot up, it will check to see if a valid application program is in the FLASH memory. If there is not, it will immediately go into the 'waiting for download' mode, 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 bootloader 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 reboot. This process will be repeated indefinitely unless you intervene.

If the bootload/application launch sequence appears to be caught in a loop, type "recover" right after the bootloader version string is displayed. This will cause the bootloader to ignore the presence of what it thinks is a valid application program in FLASH and 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.

Upgrade Using Linux and Minicom

Using **`minicom`** to perform the upgrade can be problematic. Follow this procedure:

1. Use **`minicom`** to talk to the unit. Issue the **`upload`** command and wait for the "**`C`**" characters to start.

2. Now exit from **`minicom`** with CTRL-A Q. Then type this command:

```
lsz -Xk binfile </dev/ttyS?? > /dev/ttyS?? 2>&1
```

where binfile is the name of the file to upload and ttyS?? is the communication port you are using.

Appendix C

Backwards Compatibility

The Praecis II is a second generation in a product series. First generation products were the Praecis Ct and the Praecis Cf. The Praecis II replaces both the Praecis Ct and Praecis Cf. This appendix is for those customers who were previous users of these older models and want to know exactly what the differences are. For those customers who cannot tolerate any change in the operation of the Praecis, because they have a software interface written specifically for the older models - there is a special configuration of the Praecis II that will mimic, as closely as possible, the Praecis Ct or the Praecis Cf. These special configurations are described at the end of this appendix.

Praecis II and Praecis Cf Differences

North American PCS

The major difference between the Praecis II and the Praecis Cf is that the Praecis II can synchronize to both North American CDMA cellular frequencies (800 MHz) and PCS frequencies (1900 MHz). The Praecis Cf would only use the cellular frequencies. Adding the capability to use the North American PCS frequencies is a big benefit as the Praecis will now operate in some areas where it previously could not.

The channelset command has been changed slightly by adding a new parameter “p” to force the Praecis to search PCS channels:

```
channelset = p
```

Time-of-Day Message

The EndRun time-of-day message format has been changed to add leap seconds information. This is the message format for the response to the **TIME** command, is used for event timetagging (see **EVENT**), and is one of the selections for the continuous, once-per-second output (see **CTIME**). Refer to ***Chapter 3 - Control and Status Commands*** for a description of these commands.

Praecis II time-of-day message:

```
T YYYY DDD HH:DD:SS zZZ m CC FF
```

The last fields, CC and FF, are the current and future leap seconds. The Praecis Cf does not have these fields as shown below:

```
T YYYY DDD HH:DD:SS zZZ m
```

For detailed information on each field in the time-of-day messages, and the other message formats available, see ***Chapter 4 - Time-Of-Day Messages***.

Changing Channelset

In the Praecis Cf, if the unit is locked when you enter the **CHANNELSET** command, then you also need to enter a **REACQUIRE** command in order to force the unit to start searching for a new CDMA signal. (See ***Chapter 3 - Control and Status Commands*** for details on **CHANNELSET** and **REACQUIRE**.)

In the Praecis II, even if the unit is locked, it will automatically start searching for a new CDMA signal as soon as you enter the **CHANNELSET** command.

Additional Fault Indicators

Two new fault indicators have been added to the **FLTSTAT** command response. These are the Time Input Fault and the Main Osc Failure. See **FLTSTAT** in ***Chapter 3 - Control and Status Commands*** for details.

Version Information

In response to the **VER** command, the Praecis sends firmware and FPGA version information. This message is slightly different between the Praecis II and the Praecis Cf. See ***Chapter 3 - Control and Status Commands*** for a description of this command.

Praecis II version information:

```
Praecis II FW 6010-0063-000 v 1.00  - Jun 25 2010 16:41:39
FPGA 6020-0008-000 v 01<CR><LF>
```

Praecis Cf version information:

```
Praecis Cf FW 6010-0001-000 v 1.00 - Sep 18 2007 16:41:39
FPGA 6020-0001-000 v 01<CR><LF>
```

Additional Commands

The following commands are new and did not exist in the Praecis Cf: **FLTMSG** and command-specific **HELP**. See ***Chapter 3 - Control and Status Commands*** for more information on these new commands.

Praecis II and Praecis Ct Differences

North American PCS

The major difference between the Praecis II and the Praecis Ct is that the Praecis II can synchronize to both North American CDMA cellular frequencies (800 MHz) and PCS frequencies (1900 MHz). The Praecis Ct would only utilize the cellular frequencies. Adding the capability to use the North American PCS frequencies is a big benefit as the Praecis will now operate in some areas where it previously could not.

The channelset command has been changed slightly by adding a new parameter “p” to force the Praecis to search PCS channels:

```
channelset = p
```

Additional Outputs

There are two new outputs on the Praecis II that did not exist in the Praecis Ct. These are a 1 Pulse-Per-Second (1PPS) and 10 MHz, both on SMA connectors. Specifications are shown in ***Appendix D - Specifications***.

Pulse Width

The factory default setting for the 1PPS signal is one millisecond wide in the Praecis II. In the Praecis Ct, the 1PPS pulse width was dependent upon the baud rate of the serial port. The 1PPS signal is output on the RS-232 Data Carrier Detect (DCD) line and the new SMA connector. To change the 1PPS pulse width to match that of the old Praecis Ct simply use the **PULSEWIDTH** command as:

```
PPSWIDTH=NTP
```

This setting will be saved in non-volatile memory so you will not need to do this again unless you reset factory default settings using the Indicator Mode Button as described in Chapter 6.

Time-of-Day Message

The EndRun time-of-day message has been changed to add leap seconds information. This is the message format for the response to the **TIME** command, is used for event timetagging (see **EVENT**), and is one of the selections for the continuous, once-per-second output (see **CTIME**). Refer to ***Chapter 3 - Control and Status Commands*** for a description of these commands.

Praecis II time-of-day message:

```
T YYYY DDD HH:DD:SS zZZ m CC FF
```

The last fields, CC and FF, are the current and future leap seconds. The Praecis Ct does not have these fields as shown below:

```
T YYYY DDD HH:DD:SS zZZ m
```

For detailed information on each field in the time-of-day messages, and the other message formats available, see ***Chapter 4 - Time-Of-Day Messages***.

Changing Channelset

In the Praecis Ct, if the unit is locked when you enter the **CHANNELSET** command, then you also need to enter a **REACQUIRE** command in order to force the unit to start searching for a new CDMA signal. (See ***Chapter 3 - Control and Status Commands*** for details on **CHANNELSET** and **REACQUIRE**.)

In the Praecis II, even if the unit is locked, it will automatically start searching for a new CDMA signal as soon as you enter the **CHANNELSET** command.

Additional Fault Indicators

Two new fault indicators have been added to the **FLTSTAT** command response. These are the Time Input Fault and the Main Osc Failure. See **FLTSTAT** in ***Chapter 3 - Control and Status Commands*** for details.

Version Information

In response to the **VER** command, the Praecis sends firmware and FPGA version information. This message is slightly different between the Praecis II and the Praecis Ct. See ***Chapter 3 - Control and Status Commands*** for a description of this command.

Praecis II version information:

```
Praecis II FW 6010-0063-000 v 1.00  - Jun 25 2010 16:41:39
FPGA 6020-0008-000 v 01<CR><LF>
```

Praecis Ct version information:

```
Praecis Ct FW 6010-0001-000 v 1.00 - Sep 18 2007 16:41:39
FPGA 6020-0001-000 v 01<CR><LF>
```

Additional Commands

The following commands are new and did not exist in the Praecis Ct: **FLTMSG**, **PPSWIDTH**, and command-specific **HELP**. See ***Chapter 3 - Control and Status Commands*** for more information on these new commands.

Legacy Product Configurations

The Praecis Ct and the Praecis Cf have been produced for many years. As such, over the years there has been developed equipment by other manufacturers intended to interface with these older products. In order to avoid disrupting this relationship, the Praecis II may be configured to mimic, as closely as possible, these older legacy products.

Praecis Cf Mode Configuration

Not too many differences exist between the Praecis II and the Praecis Cf. However, the version information may cause problems for some equipment that has been developed to work specifically with the Praecis Cf. The Praecis Cf Mode will solve this problem by responding to the **VER** command as closely as possible to the way the Praecis Cf did. This should be sufficient to maintain interoperability between the Praecis II (configured as Praecis Cf Mode) and other equipment.

Version information (**VER** command) for Praecis II configured as Praecis Cf Mode:

```
Praecis Cf FW 6010-0063-000 v 1.00  - Jun 25 2010 10:46:22
Praecis FPGA 6020-0008-000 v 01<CR><LF>
```

In addition, the EndRun time-of-day message will NOT have leap seconds appended to it, which will match that of the Praecis Cf.

However, besides the response to the **VER** command, there are two othe small differences that remain. The unit will respond instantly to a **CHANNELSET** command and there are two new fault bits in response to the **FLTSTAT** command. See details in the ***Praecis II and Praecis Cf Differences*** section above.

Praecis Ct Mode Configuration

The Praecis II version information may cause problems for some equipment that has been developed to work with the Praecis Ct. The Praecis Ct Mode will solve this problem by responding to the VER command as closely as possible to the way the Praecis Ct did. This should be sufficient to maintain interoperability between the Praecis II (configured as Praecis Ct Mode) and other equipment.

Version information (**VER** command) for Praecis II configured as Praecis Ct Mode:

```
Praecis Ct FW 6010-0063-000 v 1.00  - Jun 25 2010 16:41:39
Praecis FPGA 6020-0008-000 v 01<CR><LF>
```

In addition, the EndRun time-of-day message will NOT have leap seconds appended to it, which will match that of the Praecis Ct. Also, the pulse width of the 1PPS Output on DCD will be set according to the baud rate of the serial port, which will match the 1PPS pulse width of the Praecis Ct. Therefore, the **PPSWIDTH** command is not available for the Praecis Ct Mode.

However, besides the response to the **VER** command, there are two othe small differences that remain. The unit will respond instantly to a **CHANNELSET** command and there are two new fault bits in response to the **FLTSTAT** command. See details in the ***Praecis II and Praecis Ct Differences*** section above.

*LEGACY Command

This is a special command intended only for those who require changing the configuration of the Praecis II to one of the legacy product configurations: Praecis Cf or Praecis Ct. Once this has been changed it will not be affected by resetting factory defaults (see ***Chapter 6 - Indicator Mode Button***).

When you change the ***LEGACY** setting the unit will automatically reset factory defaults. You will need to type a **RESET** command to restart the unit and properly set up hardware for your new configuration.

***LEGACY** is not shown in the Praecis II **HELP** menu, nor as part of the response to the **SETTINGS** command. Syntax is: ***LEGACY**=x, where x is 1 for Praecis II, 2 for Praecis Cf Mode and 3 for Praecis Ct Mode.

Query:	***LEGACY<CR><LF>**
Praecis II response:	***LEGACY=1 (Praecis II)** Unless specified at time of order, all Praecis II are shipped with this configuration.
Query:	**HELP *LEGACY<CR><LF>**
Praecis II response:	Information related to the ***LEGACY** command is displayed.
Set:	***LEGACY=2<CR><LF>**
Praecis II response:	**OK** The unit will automatically reset factory defaults to those of Praecis Cf Mode. You will need to type a **RESET** command in order to properly set up the hardware. The new *LEGACY setting will be stored in FLASH and remain configured as a Praecis Cf until you specifically change it using the ***LEGACY** command.

Appendix *D*

Specifications

CDMA Receiver:
Cellular Mobile Receive Band – 869-894 MHz (Standard).
North American PCS Mobile Receive Band - 1930-1990 MHz (Standard).
Japanese Cellular Mobile Receive Band - 860-875 MHz (Optional Configuration)
TIA/EIA IS-95 CDMA Pilot and Sync Channels.

Magnetic-Mount Antenna:
SMA plug, Zin = 50 ohms.
Dual Band, 824-896 MHz/1850-1990 MHz.
Magnetic-base monopole with integral 12 ft. RG-58/U cable and SMA plug.
Extension cables and low-noise pre-amplifiers are available as options.

Helical Antenna:
SMA plug, Zin = 50 ohms.
Dual Band, 824-896 MHz/1850-1990 MHz.

Local Oscillator:
TCXO is standard ($2.5x10^{-6}$ over -20° to 70°C).
Option: OCXO ($4x10^{-9}$ over 0 to 70°C).

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

Indicators:
Lock LED: Green LED pulses to indicate CDMA acquisition and lock status.
Alarm LED: Red LED indicates a fault condition.
Indicator Mode Button: Dual Functions - restores factory defaults and selects LED mode (Normal or Signal Quality).

1 Pulse-Per-Second (1PPS) Timing Characteristics:

Signal: Positive TTL pulse @ 50Ω.
Accuracy: <10 microseconds to UTC typical when locked. Fringe area reception may degrade the absolute timing accuracy due to increase propagation delay.
Stability: TDEV < 50 ns, t < 104 seconds.
Connector: SMA bulkhead jack.

10 MHz Frequency Characteristics:

Signal: Positive TTL pulse @ 50Ω.
Accuracy: $< 10^{-11}$ to UTC for 24-hour averaging times when locked.
Stability: $\sigma_y(\tau) < 10^{-9}$ for $\tau < 10^2$ seconds, $\sigma_y(\tau) < 10^{-7}/\tau$ for $\tau > 10^2$ seconds.
Connector: SMA bulkhead jack.

I/O Signals:

DCD: Output at RS-232 levels. See DCD 1 Pulse-Per-Second Output Characteristics (below).
CTS: Input at RS-232 levels. See CTS Input Event Timetagging Characteristics (below).
Serial I/O: RXD, TXD at RS-232 levels.
User-selectable parameters: 9600, 19200, 38400, 57600 baud; 7 or 8 data bits; odd, even or no parity; 1 or 2 stop bits.
Connectors: RJ-45 Connector. RJ-45 to DB9F adapter/cable assembly included.

RJ-45 Pin on Praecis II	DB9F Pin on Adapter	Signal Name
1	1	**Data Carrier Detect (DCD)** DCD is driven by the 1PPS signal from the Praecis II. Falling edge is on-time.
2	2	**Transmit Data (TXD)** TXD is driven by the Praecis II.
3	3	**Receive Data (RXD)** RXD is driven by the host computer.
4	4	Not Connected
5	5	**Ground (GND)** GND is connected to the power supply ground on the Praecis II.
6	6	Not Connected
7	7	**Clear To Send (CTS)** CTS is driven by Request To Send (RTS) from the host computer. The Praecis II timetags the rising edge of CTS when the Event timetagging function is ON (see the EVENT command), or if the Praecis II is operating in Trimble Palisade emulation mode (see the EMUL command).
8	8	Not Connected

DCD 1 Pulse-Per-Second Output Characteristics:

Signal: RS-232 levels, falling edge is on-time.
Accuracy: Same as the 1PPS Timing Accuracy (above).

CTS Input Event Timetagging Characteristics:

Signal: RS-232 levels. Rising edge can be captured with 32 nanosecond resolution.
Accuracy: Same as the 1PPS Timing Accuracy (above).
Resolution: 32 nanoseconds.
Pulse Width: 100 nanoseconds, minimum.
Re-Arm Delay: 1 milliseconds, 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.

Power:

Connector: 3.5mm phone jack.
6 VDC @ 400 mA, Universal AC.
AC wall adapter is included.

Size:

Case:	4.85”L x 2.68”W x 1.18”H
Weight:	1/2 pound. (270 grams)
Helical Antenna:	4.25”L x 0.40” diameter
Mag-Mount Antenna:	2” diameter at base by 14” H

Environmental:

Temperature:	0° to +70°C
Humidity:	0 to 95%, non-condensing

Compliance:

FCC Part 15 Subpart B Class A

Special Modifications

Changes for Customer Requirements

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

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