

Lucent Technologies  
Bell Labs Innovations



# Lucent Technologies

## Reference Frequency and Timing Generator User Documentation

Issue 1.0

**November 1, 1996**

---

Palash Desai

Approved By:

---

Ronald A. Lemp

This document is controlled by the Whippany Quality Library.  
***This may not be the most current version of this document.***  
Contact the Whippany Quality Library to verify the most current version.

Lucent Technologies Proprietary  
Use Pursuant to Company Instructions

# Table of Contents

<b>1. INTRODUCTION .....</b>	<b>6</b>
<b>2. THE REFERENCE FREQUENCY AND TIMING GENERATOR .....</b>	<b>6</b>
2.1 RFTG FUNCTIONALITY.....	6
2.2 THE GLOBAL POSITIONING SYSTEM.....	7
2.3 USING GPS TO DISCIPLINE THE Rb AND XO OSCILLATORS .....	8
2.4 LOSS OF GPS AND FLYWHEELING.....	9
2.5 OPERATIONAL MODES OF THE RFTG .....	9
<b>3. RFTG LIST NUMBERS .....</b>	<b>11</b>
<b>4. RFTG DIAGNOSTIC SOFTWARE .....</b>	<b>11</b>
4.1 INTRODUCTION .....	11
4.2 HARDWARE AND SOFTWARE REQUIREMENTS .....	11
4.3 DIAGNOSTIC SOFTWARE INSTALLATION .....	12
4.4 SETTING UP THE DIAGNOSTIC SOFTWARE .....	12
4.5 MESSAGE STRING .....	15
<b>5. INITIAL INSTALLATION PROCEDURES .....</b>	<b>18</b>
5.1 INTRODUCTION .....	18
5.2 ENTERING THE LENGTH OF THE GPS ANTENNA CABLE .....	18
5.3 SETTING COORDINATES .....	20
<b>6. VIEWING THE STATUS OF THE GPS RECEIVER.....</b>	<b>23</b>
6.1 INTRODUCTION .....	23
6.2 USING THE DIAGNOSTIC SOFTWARE TO DETERMINE THE STATUS OF THE GPS RECEIVER .....	23
<b>7. VIEWING ADDITIONAL INFORMATION.....</b>	<b>25</b>
7.1 INTRODUCTION .....	25
7.2 VIEWING THE REF 0 RUBIDIUM ELECTRICAL CHARACTERISTICS .....	25
7.3 VIEWING THE REF 1 CRYSTAL ELECTRICAL CHARACTERISTICS.....	27
<b>8. HARD AND SOFT RESETS .....</b>	<b>29</b>
8.1 RESETTING THE REF 0 (RUBIDIUM) MODULE (L012A) .....	29
8.2 RESETTING THE REF 1 (CRYSTAL) MODULE. ....	30
8.3 RESETTING MODULES L102 AND L104.....	31
<b>9. HOT-SWAPPING MODULES .....</b>	<b>31</b>
9.1 HOT-SWAPPING THE REF 0 (RUBIDIUM) MODULE.....	32
9.2 HOT-SWAPPING THE REF 1 (CRYSTAL) MODULE.....	33
<b>10. TROUBLE SHOOTING THE RFTG .....</b>	<b>35</b>
10.1 INTRODUCTION .....	35
10.2 THE RFTG REF 1 YELLOW <i>No GPS</i> LIGHT IS FLASHING .....	35
10.3 THE RFTG YELLOW <i>NO GPS</i> LIGHTS ARE LIT. ....	35
10.3.1 <i>Correcting for Flywheel Conditions on the RFTG L1</i> .....	36
10.3.2 <i>Correcting for Flywheel Conditions on the RFTG L1A</i> .....	37
10.3.3 <i>Correcting for Flywheel Conditions on the RFTG L1B</i> .....	37

10.4 RECOVERY FROM “GPS RX FAIL” MESSAGE PROCEDURE.....	38
10.4.1 GPS RX Fail Message due to the RFTG timing conflict.....	38
10.4.2 Fly-wheel.....	38
10.4.3 GPS RX Fail message due to a failed receiver.....	39
10.5 THE RED 15 MHZ ALARM LIGHT IS ON.....	39
10.5.1 Only the Ref 0 Red 15 MHz Alarm light is on.....	39
10.5.2 Only the Ref 1 Red 15 MHz Alarm light is on.....	39
10.5.3 Both Red 15 MHz Alarm Lights are Lit.....	40
10.6 HARDWARE ERROR HANDLER (HEH).....	41
<b>11. REFERENCES.....</b>	<b>45</b>
<b>12. INDEX.....</b>	<b>46</b>

## List of Figures

Figure 1: Normal mode screen.....	13
Figure 2: Initiating the Set Configuration command.....	13
Figure 3: RFTG configuration screen. Only the <b>A/D Bits</b> field should be modified. ....	14
Figure 4: Comm Port pop-up window. ....	15
Figure 5: Relative position of bits.....	17
Figure 6: Setting the cable delay parameter.....	19
Figure 7: Setting the Cable Delay parameter on the Crystal side.....	20
Figure 8: Selecting <i>Set RB-XO</i> .....	22
Figure 9: Coordinates pop-up window. ....	23
Figure 10: Initiating the Request for GPS Receiver Status. ....	24
Figure 11: GPS Receiver Status screen. ....	24
Figure 12: Requesting the Voltages Rb screen.....	26
Figure 13: Rubidium (Ref 0) Voltage screen.....	27
Figure 14: Requesting the Voltages XO screen.....	28
Figure 15: Electrical characteristics of the Ref 1 (Crystal) module. ....	28
Figure 16: Resetting the Ref 0 (Rubidium) module. ....	29
Figure 17: Initiating the <i>Replace Rb</i> command. ....	30
Figure 18: Resetting the Ref 1 (Crystal) module.....	31
Figure 19: Initiating the <i>Replace Rb</i> command. ....	33
Figure 20: Sequence of error bits in each error byte.....	42

## List of Tables

Table 1: Definition of LEDs. ....	6
Table 2: LED status of an <i>active</i> module for different modes of operation. ....	10
Table 3: LED status of a module is <i>Standby</i> for different modes of operation. ....	10
Table 4: Hardware requirements for the RFTG Diagnostic Software. ....	11
Table 5: Interpretation of ASCII characters. ....	16
Table 6: Interpretation of the Status characters. ....	16
Table 7: Chart to convert Hexadecimal to Binary ....	16
Table 8: Interpretation of bits from Alarm Character 1. ....	17
Table 9: Interpretation of Alarm Character 2. ....	17
Table 10: Interpretation of Alarm Character 3. ....	17
Table 11: Interpretation of Alarm Character 4. ....	17
Table 12: Definition of various GPS Receiver status. ....	24
Table 13: Current drawn from antennas of various gains. ....	28
Table 14: List numbers for various versions of the RFTG. ....	36
Table 15: Format of RFTG ROP data. ....	41
Table 16: Definition of the AA ASCII Pair. AA refers only to the Ref 0 module. ....	41
Table 17: Definition of the BB ASCII pair. ....	41
Table 18: Conversion from Hexadecimal to Binary ....	42
Table 19: Definition and severity of error bytes for the Ref 0 module. ....	43
Table 20: Definition of severity classes. ....	43
Table 21: Definition and severity of the Ref 1 error bytes. ....	44
Table 22: RFTG status displayed on MCRT screen given Alarm status of Ref 0 and Ref 1. ....	45

# 1. Introduction

This document discusses the operation and maintenance of the Reference Frequency and Timing Generator (or simply RFTG). The RFTG provides the 15 MHz reference frequency and 1 pulse per second (1 PPS) timing signal that drive the Series II AMPS and CDMA systems. For proper operation, the 15 MHz signal must remain accurate in frequency and the 1 PPS signal must remain accurate in phase. The RFTG was developed to meet these demands.

This document begins by detailing the functionality of the RFTG including the technology uses to maintain timing signals of accurate frequency and phase. Next, the RFTG Diagnostic Software package is described. The Diagnostic Software is a tool used to install and trouble shoot the RFTG. In later sections, a guide to trouble shooting the RFTG is discussed in great detail. In that section, specific problems and their solutions using the Diagnostic Software tool are described.

## 2. The Reference Frequency and Timing Generator

### 2.1 RFTG Functionality

The RFTG is a redundant signal generator which generates a 15 MHz signal and a 1 PPS signal in addition to alarm and status signals. It consists of two plug-in modules interconnected by a housing frame. The left module is referred to as Ref 0 while the right module is referred to as Ref 1. At the front of the housing frame are six female TNC connectors (which feeds the 15 MHz signal) labeled J1 through J6 and three DB15 female connectors (which feed the 1 PPS, alarm and status signals) labeled J7 through J9. Additionally there are two sets of four (4) LEDs. The set of LEDs on the left displays the status of the Ref 0 module and the set of LEDs on the right displays the status of the Ref 1 module. Table 1 provides the definition of each LED.

LED label (and color)	Definition
No GPS (yellow)	Module is not receiving GPS signals and is flywheeling.
15 MHz Alarm (red)	Module is warming-up or module has failed.
Stdby (yellow)	Module has warmed up but is not active.
On (green)	Module has warmed up and is active.

Table 1: Definition of LEDs.

Each module contains an oscillator. The Ref 0 module uses a Rubidium oscillator while the Ref 1 module uses a crystal quartz oscillator. Each module will use the signal generated by its oscillator to generate a 15 MHz signal and a 1 PPS signal. Since each module is capable of generating the 15 MHz and 1 PPS signal, the RFTG is a redundant system. The *active* module is the module that provides the 15 MHz and 1 PPS signals to the AMPS and CDMA systems. The module that is in *standby* is the redundant module. If the active module fails, the redundant

module will become active and provide the 15 MHz and 1 PPS signals to the AMPS and CDMA systems.

The housing frame of the RFTG hosts a toggle switch which allows the user to choose which module is active and which module is in standby mode. Normally, the toggle switch should be set to Ref 0 thereby making the Ref 0 module the active module and the Ref 1 module the redundant module.

## **2.2 The Global Positioning System**

The NAVSTAR Global Position System (GPS) is a satellite based radio navigation system designed and operated by the United States Department of Defense. It provides three dimensional position, timing and velocity information traceable to the UTC (Coordinated Universal Time) on a global basis.

GPS consists of 24 satellites which orbit the Earth in a semi-synchronous fashion in six orbital planes. Each orbital plane is inclined 55 degrees relative to the equator and are spaced at 60 degree increments around the equator. GPS satellites contain two Cesium and two Rubidium atomic clocks which are periodically phase locked to one of many ground based Cesium atomic clocks operated by the Department of Defense and the National Institute of Standards and Technology. Each satellite transmits precise timing information as uniquely encoded data transmissions which are derived from the on board atomic clocks. A GPS receiver will receive these transmissions which enables it to determine its distance from any given satellite by measuring the arrival time of each signal. Because each satellite broadcasts its own position data, a GPS receiver can use transmitted signals from four GPS satellites to determine its three dimensional position and time.

GPS satellites transmit on two frequencies. One frequency is reserved for military use only and the other is for civilian use (1.575 GHz). The GPS signals used by civilians is dithered by the military by adding jitter to the timing information. The dithering of the timing information is referred to as *Selective Availability*. This reduces the accuracy of calculating position. The GPS satellites encode their transmissions using pseudo-random modulation. Each satellite has a different PRN code sequence which allows a GPS receiver to distinguish one satellite transmission from another.

Once the GPS receiver has acquired its position, the signals from the satellites can be used to generate accurate timing signals. These timing signals are the basis in which the RFTG *disciplines* the output signals generated by the Rubidium and Crystal oscillators.

## 2.3 Using GPS to Discipline the Rb and XO Oscillators

As mentioned in Section 2.1, each module contains an oscillator whose output signal is used to generate a 15 MHz and 1 PPS signal. However, due to aging and changes in environment, the output signal of the oscillator will begin to change in frequency. This change causes the frequency of the 15 MHz signal to change and causes the *phase* of the 1 PPS signal to change. Since the AMPS and CDMA systems require that the 15 MHz signal be stable in frequency and the CDMA system also requires the 1 PPS signal be stable in phase, the output of the oscillator needs to be modified (or *disciplined*) periodically. The GPS system is used to discipline the oscillators.

In addition to the Crystal oscillator, the Ref 1 module contains a GPS receiver board. The receiver board receives GPS signals from the GPS antenna through the GPS antenna port located at the front of the Ref 1 module. Upon startup, the receiver board will look for at least four satellites to lock on to. In this context, locking on to a satellite means that the receiver has successfully decoded the transmitted signals from a satellite and is receiving data from it. If the antenna has a clear view of the horizon, the receiver will lock on to four or more satellites within two minutes.

Once locked to four satellites, the receiver will begin calculating its position. Because of selective availability, there is inherent error in calculating position. Therefore, the receiver will continue to calculate and average its position for 12 hours on a running average basis. After 12 hours, the receiver will have calculated and stored a very accurate position.

During the first 12 hours after startup, the receiver uses three satellite signals to determine its position and the fourth satellite to extract timing information. The timing information is used by the receiver to generate a 1 PPS signal. The 1 PPS signal generated by the receiver becomes the reference by which the Rubidium and Crystal oscillators are disciplined.

As the output of the oscillators begins to vary in frequency, the phase of the 1 PPS signal derived from the oscillator will begin to vary in phase. Microprocessors internal to the Ref 0 and Ref 1 independently measure the shifts in phase by comparing the phase of the 1 PPS derived from the oscillator to the phase of the 1 PPS signal generated by the GPS receiver board. The microprocessor then digitally corrects for the shifts in phase.

In addition to correcting for shifts in phase of the 1 PPS signal, it is necessary that the frequency of the 15 MHz signal is also corrected. The changes in frequency are not measured directly. They are, however calculated by determining how the phase of the 1 PPS signal (derived from the output signal of the oscillator) changes with time.<sup>1</sup> Once the frequency offset has been determined, the output frequency of each oscillator can be adjusted by changing the control

---

<sup>1</sup>Recall that the 1 PPS signal is derived from the 15 MHz signal. Therefore the frequency offset can be calculated by observing that  $f = \partial\phi/\partial t$  where  $\phi$  is the measured phase error of the 1 PPS signal and  $t$  is time.



voltage across it. When the phase of the 1 PPS signal and frequency of the 15 MHz signal have been corrected, the RFTG is said to have been *disciplined*.

Previously, it was mentioned that during the first 12 hours after startup, the GPS receiver will average its position. After 12 hours, however, it no longer needs to calculate and average its position. The receiver only needs to generate the 1 PPS timing signal. This can be accomplished by locking on to only one satellite. However, because of selective availability, locking on to only one satellite limits the accuracy of the 1 PPS signal generated by the GPS receiver. Alternatively, the GPS receiver can employ an algorithm known as T-RAIM in which it locks to multiple satellites and extracts timing information from each. It then compares the timing information to each other to see if any of the timing signals differs significantly from the rest. If such a signal exists, the algorithm discards that signal and averages the rest. If all signals seem to concur with each other then the algorithm simply averages them and generates a 1 PPS signal.

## 2.4 Loss of GPS and Flywheeling

There may be times when the GPS receiver will not receive any signals from the GPS satellites. In this situation, the receiver will not be able to generate a 1 PPS signal by which the RFTG is disciplined. This situation is referred to as *flywheeling*. When an RFTG is in flywheel mode, the RFTG will continue to generate the 15 MHz signal and 1 PPS signal. Of course, due to environmental changes and aging, the output signals from both oscillators will continue to drift in phase and frequency. However, if the Ref 0 module (Rubidium) is active, the RFTG will be able to maintain a 1 PPS output with acceptable phase for a period of up to 24 hours. If Ref 1 is active, then the RFTG will be able to maintain an acceptable 1 PPS for up to 4 hours. During this time, the GPS receiver should have been able to recover from flywheel. That is, the GPS receiver should be able to lock onto at least one satellite and recommence generating 1 PPS timing signals. When the GPS receiver recovers from flywheel, the microprocessors in the Ref 0 and Ref 1 modules will measure phase error and make corrections.

## 2.5 Operational Modes of the RFTG

There are four modes that each module could be in:

1. Warm-up mode
2. Locked to GPS
3. Flywheeling
4. Unit failure.

When the RFTG is powered up, it enters a Warm-up mode. During this time, the GPS receiver tries to acquire at least four satellites and the oscillators are heated to their operational temperatures. The Ref 0 (Rubidium) module will stay in warm-up mode for 15 minutes and the Ref 1 (Crystal) module will stay in warm-up for 16 minutes. During the warm-up phase, the red *15 MHz Alarm* LEDs will be lit as will the yellow *No GPS* LEDs. Once the warm-up phase has

completed, the *15 MHz Alarm* lights will extinguish. About one minute later, the yellow *No GPS* lights will also extinguish. At this time, the Ref 0 green *On* LED will illuminate and the Ref 1 yellow *Stby* light will illuminate (assuming that the toggle switch is switched to Ref 0).

If the RFTG, during warm-up, is unable to acquire four satellites, it will not come out of warm-up. However, the red *15 MHz Alarm* lights will extinguish (within 16 minutes of power-up) and the RFTG will generate the 15 MHz signals. This will be sufficient to operate the AMPS frame. The yellow *No GPS* lights will remain lit until the unit has acquired four satellites at which time the unit will come out of warm-up and start generating the 1 PPS signal.

If the GPS receiver has acquired at least 4 satellites and there are no internal RFTG failures, the RFTG will come out of the warm-up state. At this time, the RFTG will be producing a 15 MHz signal and 1 PPS signal. When in this state, the RFTG is said to be *Locked to GPS*.

If the unit is locked to GPS and then loses all GPS signals, the RFTG is said to be *Flywheeling*. When flywheeling, the yellow *No GPS* lights will illuminate.

If one of the modules fails due to some problem, that module will report a *Unit Failed*. At this time, the red *15 MHz Alarm* LED of the side that has failed will illuminate.

State	Yellow <i>No GPS</i>	Red <i>15 MHz Alarm</i>	Yellow <i>Stby</i>	Green <i>On</i>
Warm-up (GPS)	ON	ON	OFF	OFF
Warm-up (No GPS)	ON	OFF	OFF	ON
Locked to GPS	OFF	OFF	OFF	ON
Flywheel	ON	OFF	OFF	ON
Unit Failed	OFF	ON	OFF	OFF

Table 2: LED status of an *active* module for different modes of operation.

State	Yellow <i>No GPS</i>	Red <i>15 MHz Alarm</i>	Yellow <i>Stby</i>	Green <i>On</i>
Warm-up (GPS)	ON	ON	OFF	OFF
Warm-up (No GPS)	ON	OFF	ON	OFF
Locked to GPS	OFF	OFF	ON	OFF
Flywheel	ON	OFF	ON	OFF
Unit Failed	OFF	ON	OFF	OFF

Table 3: LED status of a module is *Standby* for different modes of operation.

### 3. RFTG List Numbers

The RFTG is the implementation of the Lucent Technologies KS-24019 specifications. The RFTG as a whole has list numbers of L1, L1A or L1B. The Ref 0 module has list numbers 102 or 102A. The Ref 1 module has list numbers, 104, 104A or 104B.

### 4. RFTG Diagnostic Software

#### 4.1 Introduction

In this section, the Diagnostic Software package will be discussed. It interfaces with the RFTG via an RS-422 protocol and serves two primary purposes. If a problem in a cell exists, and the RFTG is suspected of being the source of the problem, the Diagnostic Software can be used to see if any problems or failures have occurred within the RFTG. The second purpose of the software revolves around RFTG installation. If the antenna cable, which connects the GPS antenna to the RFTG, exceeds 100 ft, then the antenna length must be entered into the RFTG via the Diagnostic Software. Entering the cable length allows the RFTG to compensate for the timing delays incurred due to the length of the cable. Moreover, upon initial startup, the RFTG requires four GPS satellites be visible which allows the unit to acquire an accurate position of the antenna location. However, in some installations, it may not be possible to see four satellites on a consistent basis. In this case, the exact coordinates of the antenna location need to be entered manually. Entering the coordinates is achieved by using the *Set Coordinates* command in the Diagnostic Software.

This section begins by detailing the hardware requirements needed to operate the Diagnostic Software. It then proceeds to describe the installation process. Finally, some of the basic functions are outlined with specific examples.

#### 4.2 Hardware and Software Requirements

Table 4 shows the hardware necessary to use the Diagnostic Software. It is important that the correct version (TBD) of the software be used. The version should be marked on the floppy disk containing the software.

Hardware and Software Needed	How to obtain hardware
Laptop with one PCMCIA Type II slot	
Microsoft Windows 3.11 or higher	
Quatech card (part SSP-200/300)	(800) 553 1170
Interface cable	Lucent CIC (800) 432 6600
RFTG Diagnostic Software package (TBD)	Lucent CIC (800) 432 6600

Table 4: Hardware requirements for the RFTG Diagnostic Software.

**Caution: The RFTG provides timing for both the CDMA frame as well as the AMPS frame. When using the Diagnostic Software, it is imperative that the directions contained in this section be followed exactly. Failure to do so may bring down the CDMA frame and could bring down the AMPS frame.**

### 4.3 Diagnostic Software Installation

Insert the Diagnostic Software disk into Drive A. From a DOS prompt enter **a:install**. Five files should be copied. Wait until the installation is complete. If Windows95 is being used, the installation can be accomplished by clicking on *Start* and selecting the *Run* menu item. In the message box type **a:install**. The Diagnostic Software can be started by running the RFTG.EXE file contained in the RFTG\_NEW folder.

### 4.4 Setting Up the Diagnostic Software

The interface cable used to connect to the RFTG has a DB15 connector on one end and two DB9, RS-422 connectors on the other end. The DB15 connector plugs into RFTG port J7, J8 or J9. The two RS-422 connectors on the other end are designed to plug into the short, black Quatech cable that comes with the RS-422/485 PCMCIA card. The connector labeled RFTG0 PC must be connected when interfacing with the REF0 Rubidium (Rb) unit and the connector labeled RFTG1 PC must be connected when interfacing with the REF1 Crystal (XO) unit.

The PCMCIA Quatech card must be plugged into one of the PCMCIA Type II slots. The PCMCIA slot is assigned a COM port number. The COM port number will vary from computer to computer. It is important to know *a priori* which COM port is assigned to the PCMCIA slot hosting the Quatech card. If the laptop is running Windows95, the COM port assigned to the PCMCIA slot can be determined by clicking on the PCMCIA icon in the Windows95 Task Bar.

Connect the DB15 connector to the J7, J8 or J9 connector on the RFTG. Connect the RFTG0 DB9 connector to the Quatech card. Start the Diagnostic Software package. Figure 1 shows the screen that should appear when the software package has finished loading. Depending on the configuration of the laptop used, there may or may not be data displayed on the screen.

Under the **MODE** menu select the **Set Configuration** menu item (see Figure 2). The configuration screen should appear (Figure 3). Verify that the A/D bits are set to 14. If they are not, then select the **A/D Bits** field and enter 14. Click on **OK**.

**Caution: It is imperative that none of the other fields is modified.**

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
—	RFTGM - Normal						
NORMAL				NORMAL			
MODULE:				MODULE:			
STATUS:				STATUS:			
FAIL CODE:				FAIL CODE:			
ELPD TIME:				ELPD TIME:			
GPS TIME:				GPS TIME:			
ELPD TIME:				ELPD TIME:			
MNFTR/VER:				MNFTR/VER:			
CHECKSUM:				CHECKSUM:			
MESSAGE:				MESSAGE:			

Figure 1: Normal mode screen.

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
Set I/O Port							
Normal							
Message							
Phase Error							
Enable Log							
Disable Log							
Set Comm Port							
<b>Set Configuration</b>							
Printer Setup							
Print Graphs							
Diagnostic							
Exit							

Figure 2: Initiating the Set Configuration command.

Configuration	
<p><b>RB</b></p> <p>Max Y Axis <input style="width: 80px;" type="text"/></p> <p>Min Y Axis <input style="width: 80px;" type="text"/></p> <p>Lo Alarm <input style="width: 80px;" type="text"/></p> <p>Hi Alarm <input style="width: 80px;" type="text"/></p> <p>Rate Display <input style="width: 80px;" type="text"/></p> <p>Y Axis Intercept <input style="width: 80px;" type="text"/></p> <p>UUT (Mhz) <input style="width: 80px;" type="text"/></p> <p>Freq. Offset (Hz) <input style="width: 80px;" type="text"/></p>	<p><b>XO</b></p> <p>Max Y Axis <input style="width: 80px;" type="text"/></p> <p>Min Y Axis <input style="width: 80px;" type="text"/></p> <p>Lo Alarm <input style="width: 80px;" type="text"/></p> <p>Hi Alarm <input style="width: 80px;" type="text"/></p> <p>Rate Display <input style="width: 80px;" type="text"/></p> <p>Y Axis Intercept <input style="width: 80px;" type="text"/></p> <p>A/D Bits <input style="width: 80px; background-color: #cccccc;" type="text" value="XX"/></p> <p>Freq. Cnt. Addr. <input style="width: 80px;" type="text"/></p>
<input type="button" value="Cancel"/>	<input type="button" value="OK"/>
	Auto Print <input type="checkbox"/>

Figure 3: RFTG configuration screen. Only the **A/D Bits** field should be modified.

Once the A/D bits have been set, the next step is to set the COM port. Under the **MODE** menu, select the **Set Comm Port** menu item. A pop up window should appear as shown in Figure 4. Under the Rb, select the COM port that matches the PCMCIA slot hosting the Quatech card. Under the XO, select any other COM port. For example, if the PCMCIA slot is assigned to COM port 2, then under the Rb, select **COM 2** and under XO select any other COM port (**COM 3** for example). Click **OK**. The screen should return to the **NORMAL** screen with data displayed under the Rb.

As its name implies, the **NORMAL** screen shows the operation of the RFTG providing the 15 MHz signal and timing messages to the CDMA and AMPS frames. The **MODULE** field shows which side of the RFTG the data represents. In this case the field should read *Rb*. If the Rubidium side is active, then the word **ACTIVE** should be displayed as well. The **STATUS** field indicates the current state of the RFTG and displays whether the unit is *Locked to GPS* or

*Flywheeling.* If the unit is not working properly and the red *15 MHz Alarm* light is on, then the STATUS field would indicate *Unit Failed*. The FAIL CODE indicates any problems the RFTG might be experiencing. If there are no problems, then this code would simply read *NONE*. There are two ELPD TIME fields. The first represents the number of hours the RFTG has been in its current state. The next field is the GPS TIME which is the calculated date and time. The date and time are calculated from the second EPLD TIME which represents the number of seconds elapsed since January 6, 1980. The next two fields show the version and status of the firmware embedded in each module. The final field is the MESSAGE field. This field shows the ASCII string that is relayed to the CDMA frame via the RS-422 output ports (J7, J8 and J9).

If desired, the XO side of the RFTG (Ref 1) can be viewed. Remove the RFTG0 DB9 connector from the Quatech cable and connect the RFTG1 DB9 connector. Under the MODE menu select the Set Comm Ports menu item. Beside XO, set the COM port to the COM port assigned to the PCMCIA slot hosting the Quatech card. Beside Rb, set the COM port to any other COM port. Click **OK**. The NORMAL screen should appear with the data listed under the XO side.

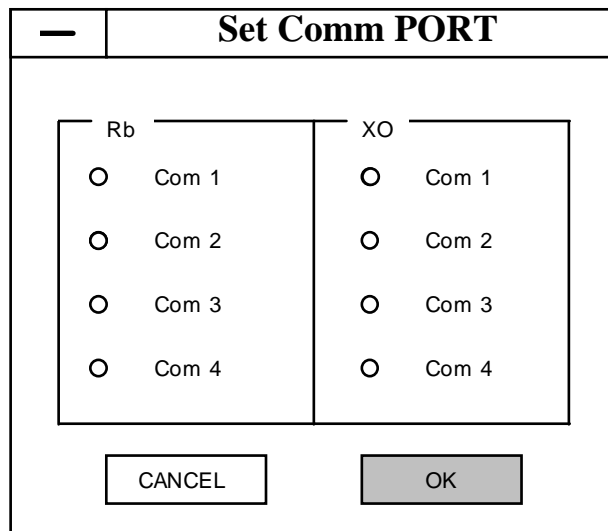


Figure 4: Comm Port pop-up window.

#### 4.5 Message String

As mentioned in the previous subsection, the last field in the NORMAL screen is the Message field. The message field is a 24 ASCII character string that the RFTG generates and sends to the CDMA frame over the J7, J8 and J9 output ports using an RS-422 protocol. In reality the message is 27 ASCII characters long. However, the Diagnostic Software only displays 24 characters (characters 0, 25 and 26 are not shown). Table 5 shows the interpretation of the ASCII characters.

Character Position	Message Meaning
0	: (colon character not shown)

Lucent Technologies Proprietary  
Use Pursuant to Company Instructions

1-4	Status
5-10	Alarm Message
11-18	GPS Time
19-22	Manufacturer/Version
23-24	Checksum
25	Carriage Return (not shown)
26	Line Feed (not shown)

Table 5: Interpretation of ASCII characters.

Table 6 shows the interpretation of the four status characters. Note that Character Position 1 refers to the left most character shown in the NORMAL screen (recall that Character Position 0 is a colon and is not shown in the NORMAL screen).

Character Position	Message Meaning
1	[0]=Message from Ref 0 [1]=Message from Ref 1
2	[0]=Module is active [1]=Module is inactive
3	Always set to zero
4	[0]=Module is in warm-up mode [1]=Module is locked to GPS [2]=Module is Flywheeling [3]=Module has failed

Table 6: Interpretation of the Status characters.

Referring to Table 5, the next six characters (Characters 5-10) refer to the alarm bits that the RFTG generates if a problem exists. These characters are actually 6 HEX ASCII characters that represent six (6) nibbles (two nibbles forms a byte). Therefore each pair of HEX characters represents a single byte. Table 7 shows the conversion from HEX to Binary.

HEX	Binary	HEX	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

Table 7: Chart to convert Hexadecimal to Binary



In order to interpret the alarm messages, the each ASCII HEX character must be converted into a binary string using Table 7. Once converted, the message can be interpreted as shown in . Please note that Bit 0 refers to the rightmost bit as shown in Figure 5.

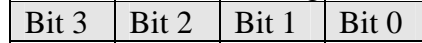


Figure 5: Relative position of bits.

Bit	Interpretation
Bit 0 =1	1 PPS output missing (output disabled)
Bit 1 =1	1 PPS greater than high threshold (output disabled)
Bit 2 =1	Antenna feed fault
Bit 3 =1	Warm-up failed

Table 8: Interpretation of bits from Alarm Character 1.

Bit	Interpretation
Bit 0 =1	Oscillator unit maintenance required
Bit 1 =1	GPS discipline board ROM test failed (output disabled)
Bit 2 =1	GPS discipline board RAM failed (output disabled)
Bit 3 =1	15 MHz output failed (output disabled)

Table 9: Interpretation of Alarm Character 2.

Bit	Interpretation
Bit 0 =1	Flywheeling failed (exceeded 8 hours)
Bit 1 =1	Internal threshold temperature exceeded
Bit 2 =1	1 PPS correction amount between 2 and 9 microseconds
Bit 3 =1	Delta temperature greater than high threshold

Table 10: Interpretation of Alarm Character 3.

Bit	Interpretation
Bit 0 =1	GPS receiver failed
Bit 1 =1	Oscillator lock failed (output disabled)
Bit 2 =1	Reserved
Bit 3 =1	Oscillator PLL lock failed (output disabled)

Table 11: Interpretation of Alarm Character 4.

The final two alarm characters represent the total time that has elapsed since the start of the operating mode described by the status code position 4 (see Table 6).

## 5. Initial Installation Procedures

### 5.1 Introduction

As previously mentioned, one of the functions of the RFTG Diagnostic Software is to aid the user in the installation of RFTGs. When the RFTG is first powered up, it requires four satellites to lock to enabling it to determine its own position. Some installations may not be able to lock to four satellites on a consistent basis. This should only occur if the GPS antenna is mounted so that it has a poor view of the sky. Every attempt should be made to relocate the GPS antenna as per the Lucent Technologies CDMA GPS Antenna Installation Guidelines. If relocation is impossible, the coordinates of the site may be entered into the RFTG by means of the Diagnostic Software. Before using this procedure, verify that the RFTG, antenna cable and antenna are not defective thereby inhibiting the GPS reception. If the number of satellites tracked (using the procedure described in Section 6) is still less than four after 15 minutes of power up, use the procedure described in Section 5.3.

In addition, there are some installations where the GPS antenna cable, which connects the GPS antenna to the RFTG, is of length greater than 100 ft. These sites typically have the equipment frames in the basement of a building while the GPS antenna is located on the roof. The RFTG firmware has a parameter called *Cable Delay* which allows the unit to compensate for any delays incurred due to long cables. The Diagnostic Software is used to set these parameter.

This section describes the procedures to set the Cable Delay parameter and to set the Coordinates of the RFTG. It is assumed, in this section, that the RFTG has already been installed. Additionally, the RFTG *must* be in the warm-up mode when these procedures are being performed.

### 5.2 Entering the Length of the GPS Antenna Cable

If the length of the GPS antenna cable exceeds 100 ft, then the Cable Length parameter in the RFTG needs to be set.

1. Using the procedures described in Section 4.4, connect the laptop computer to the RFTG and start the Diagnostic Software package.
2. Set the COM ports so that Ref 0 side is visible in the NORMAL screen (the procedure for doing this is also outlined in Section 4.4).
3. Verify that the unit is in warm-up mode. The Status field in the NORMAL screen should read *Warmup*.
4. Switch the toggle switch to the Ref 1 side.

**Warning: Step 4 must be performed. Failure to do so will bring down the CDMA frame.**

5. Under the *Control* menu select the *Set Cable Delay Rb* menu item (see Figure 6).

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
				Replace Rb Set Position XO Set Position RB-XO <b>Set Cable Delay Rb</b> Set Cable Delay XO Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO Reset CPU Rb Reset CPU XO			

Figure 6: Setting the cable delay parameter.

- A pop-up window similar to the one shown in should appear.

Set Cable Delay	
Cable Length [50-1000]	<input type="text"/>
<input type="button" value="OK"/>	<input type="button" value="CANCEL"/>

- In the Cable Length field, enter the length of the cable in feet.
- Select **OK**.
- Under the **Mode** menu, select the **Normal** menu item. The NORMAL screen should refresh and the GPS Time field should be updating. If the GPS TIME field is not updating, then select the **Normal** menu item again. The GPS Time field should be updating.

**Caution: It is VERY important that Step 7 be successfully completed to avoid unnecessary alarms are received at the MSC.**

- The Cable Delay parameter must be entered for the Crystal side as well. Switch the toggle switch to the Ref 0 position. Using the procedures outlined in Section 4.4

change the cable connections and the COM port so that the XO side is shown in the NORMAL screen.

11. Under the *Control* menu select the **Set Cable Delay XO** menu item (see Figure 7).
12. Repeat Steps 4-7 ensuring that the **Normal** menu item under the **Mode** menu is selected after the coordinates have been entered.

<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
				Replace Rb Set Position XO Set Position RB-XO Set Cable Delay Rb <b>Set Cable Delay XO</b> Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO Reset CPU Rb Reset CPU XO			

Figure 7: Setting the Cable Delay parameter on the Crystal side.

**Warning: Step 12 must be performed. Failure to do so will bring down the CDMA frame.**

### 5.3 Setting Coordinates

In this section, the procedure for setting the coordinates is described. The latitude, longitude and altitude of the cell site GPS antenna must be known before attempting to set the coordinates. Normally, the coordinates of any location are given in base DMS (degrees, minutes and seconds) notation. However, the Diagnostic software requires that the coordinates be entered in decimal (base 10) format. In order to convert from DMS to base 10 do the following:

1. Divide the number of seconds by 3600.
2. Divide the number of minutes by 60
3. Add the results of Step 1 and Step 2 to the number of degrees.

The following example shows how to convert from DMS to base 10.

### Example:

Assume that the latitude of a cell are 40° 49' 8" and the altitude is 330 feet. To convert to decimal format, do the following:

1. 8 seconds/3600 = .002
2. 49 minutes/60 = .816
3. 40 degrees + .002 +.816 = 40.818

To convert the altitude from meters to feet, divide the altitude by 3.3. Thus:

$$330 \text{ feet}/3.3 = 100 \text{ meters.}$$

The same procedure is used to convert the longitude to decimal format. To distinguish between North/South and East/West, plus (+) and minus (-) signs are used. If the latitude is North (which is the case for all North American installations) then the latitude is positive. If the latitude is South, then the result is negative. Similarly, if the longitude is East, then the result is positive and if it is West (which is the case for all North American installations), then result is negative.

Once the coordinates of the GPS antenna have been determined and converted into decimal format, it is ready to be entered using the Diagnostic Software. Using the procedures described in Section 4.4, connect the laptop computer to the RFTG and start the Diagnostic Software package. Set the COM ports so that the Ref 0 side of is visible in the NORMAL screen (the procedure for doing this is also outlined in Section 4.4). To enter the coordinates, do the following:

1. Verify that the unit is in warm-up mode. The Status field in the NORMAL screen should read *Warmup*.
2. Switch the toggle switch to the Ref 1 side.
3. Under the Control menu select the **Set Position RB-XO** (see Figure 8 ).

<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
				Replace Rb Set Position XO <b>Set Position RB-XO</b> Set Cable Delay Rb Set Cable Delay XO Set Cable Delay Rb- XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO Reset CPU Rb Reset CPU XO			

Figure 8: Selecting *Set RB-XO*.

4. A pop-up window should appear (see Figure 9). In the Latitude field, enter the latitude in *decimal* format (taking care that the proper sign is used). Enter the longitude in the Longitude field again in decimal format (again taking care that the proper sign is used). In the Altitude field, enter the altitude in meters.
5. Click **OK**.
6. Under the **Mode** menu, select the **Normal** menu item. The NORMAL screen should refresh with GPS Time field updating. If the GPS Time field is not updating, select the **Normal** menu item under the **Mode** menu again. This NORMAL screen should reappear with the GPS Time field updating.

**Caution: It is VERY important that Step 6 be successfully completed to avoid unnecessary alarms at the MSC.**

7. The coordinates must be entered for the Crystal side as well. Switch the toggle switch to the Ref 0 position. Using the procedures outlined in Section 4.4 change the cable connections and the COM port so that the XO side is shown in the NORMAL screen.
8. Repeat Steps 3-6 ensuring that the **Normal** menu item under the **Mode** menu is selected after the coordinates have been entered.

SET POSITION	
LATITUDE [-90<degrees<90]	0.00000
LOGITUDE [-180<degrees<180]	0.00000
ALTITUDE [Meters]	0.000
<input type="button" value="OK"/>	

Figure 9: Coordinates pop-up window.

## 6. Viewing the Status of the GPS Receiver

### 6.1 Introduction

When powering up the RFTG, it is often useful to determine whether the GPS receiver is able to lock onto four satellites. If it cannot, then it may be necessary to reposition the antenna.<sup>2</sup> The Diagnostic Software package can be used to interface with the GPS receiver and ascertain whether it can lock on to a sufficient number of satellites.

### 6.2 Using the Diagnostic Software to Determine the Status of the GPS Receiver

1. Using the procedures outlined in Section 4.4, connect the laptop computer and start the Diagnostic software so that the data of Ref 1 (Crystal) module is visible in the NORMAL screen.
2. Verify that the toggle switch is set to Ref 0.
3. Verify that the Ref 0 green *On* LED is lighted and the Ref 1 yellow *Stby* LED is lighted. It does not matter whether the yellow *No GPS* LEDs on either side are lit.
4. Verify that none of the red *15 MHz Alarm* LEDs is lighted.
5. Do NOT proceed unless Steps 1-4 are successfully completed.
6. Under the GPS menu, select the Status XO menu item (see Figure 10),
7. Figure 11 shows a typical example of what should appear..

**Be sure to click on the Normal menu item in the Mode menu when finished.**

<sup>2</sup> Please refer to the Lucent Technologies CDMA GPS Antenna Installation Guidelines for information about GPS antenna placement.

<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
			<b>Status X0</b>				
			Position X0				
			Go To Fix Mode X0				

Figure 10: Initiating the Request for GPS Receiver Status.

RECEIVER STATUS							
NUMBER OF VISIBLE SATS	:	8					
NUMBER OF TRACKING SATS	:	6					
RECEIVER STATUS	:	3D FIX					
-----							
CHANNEL NUMBER	:	1	2	3	4	5	6
-----							
SATELLITE ID	:	22	28	14	19	18	29
TRACKING	:	X	X	X	X	X	X
SIGNAL STRENGTH %	:	20	55	38	14	68	44
CHANNEL STATUS	:	23	19	45	3B	38	1C
USING FOR FIX	:	X	X	X	X	X	X

Figure 11: GPS Receiver Status screen.

There are several fields in the GPS Receiver Status screen shown in Figure 11. Embedded in the GPS receiver hardware is an almanac that stores the orbital paths of all active GPS satellites. Using the almanac data, the receiver can predict which satellites should be visible to the GPS antenna at a given time. At the top of the GPS Receiver Status screen, the Diagnostic Software shows some of the almanac data. *Number of Visible Sats* displays how many satellites the receiver expects to see while the *Number of Tracking Sats* displays how many satellites the receiver expects to track. The *Receiver Status* shows the state the receiver is in. The various states that the GPS Receiver can be in are summarized in Table 12.

Receiver Status	Definition
Acquiring Sats / Position Hold	The receiver is searching for satellites to acquire and lock to or the receiver has finished determining its position and is using all tracked satellites for timing.
2D-Fix	The receiver has found only 3 satellites and is unable to calculate altitude.
3D-Fix	The receiver has found at least 4 satellites and is determining its position.

Table 12: Definition of various GPS Receiver status.



When the receiver is in the *Acquiring Sats* mode, it is searching the sky for satellites to lock on to. If all aspects of the antenna installation are proper, the receiver will generally lock to at least 4 satellites within 2 minutes of power up. Once the position of the GPS antenna has been accurately determined, the firmware will then put the GPS receiver in the *Position Hold* mode. When the GPS receiver is in this mode, all data received from the GPS satellites will be used to generate timing signals according to the T-RAIM algorithm described in Section 2.3.

The GPS receiver assigns a satellite to one of six channels. Under the *Channel Number*, the GPS Receiver Status screen shows the *Satellite ID*. Each GPS satellite has a unique identification number which distinguishes it from the other GPS satellites. The *Satellite ID* field displays which satellites have been acquired by the GPS receiver. The *Tracking* field in the GPS status screen uses **X**'s to show which satellites the GPS receiver is tracking. The *Signal Strength %* is an indication of how strong the signals received from each satellite is. It must be emphasized that the Signal Strength % of a given satellite is only valid if that satellite is being tracked (that is, there is an **X** in the tracking row under a given satellite ID). The *Using for Fix* field shows which satellites the receiver is using to determine its position.

## 7. Viewing Additional Information

### 7.1 Introduction

When trouble shooting the RFTG, it often useful to see whether the RFTG modules are adhering to certain internal electrical specifications. These specifications include the control voltage across the oscillator, the voltage across the GPS antenna port and the current drawn by the GPS antenna.

### 7.2 Viewing the Ref 0 Rubidium Electrical Characteristics

1. Using the procedures outlined in Section 4.4, connect the laptop computer to the RFTG so that the Ref 0 data is displayed in the NORMAL screen.
2. Switch the toggle switch to the Ref 1 position.

**WARNING! Do NOT proceed until step 2 has been successfully completed. Failure to do so could bring down the CDMA cell.**

3. Under the **System Rb** menu, select the **Voltages Rb** menu item (see Figure 12).
4. Figure 13 shows what the screen will change to (there should be numbers next to each field)

In this screen, there is only one field that the user needs to be concerned with. That field is the *Control Voltage*. This is the voltage across the Rubidium oscillator which controls its output frequency. When the RFTG makes a frequency correction, it accomplishes it by changing the control voltage. The control voltage should be between 2.2 and 2.8 volts.

5. When finished viewing the Rb Voltages screen, it is very important to click on the **Normal** menu item in the **Mode** menu. The screen will return to the NORMAL screen and the GPS Time field should be updating.

**Warning: It is very important that Step 5 be completed to avoid bringing down the CDMA cell.**

<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
	<b>Voltages Rb</b>						
	Correction Data Rb						
	Correction History Rb						
	Additional Status Rb						
	NVM Error Storage Rb						
	Request Cable Delay Rb						
	Request WarmUp Time Rb						
	Request Delta APE						
	Rqst Constant APE						
	Rqst APE 1						
	Rqst APE 2						
	Rqst APE						
	Rqst Delta Temp						
	Rqst Hardware Version						
	Rqst Avg Sample						
	Rqst Time Corr Schedule						
	Rqst Freq Corr Schedule						

Figure 12: Requesting the Voltages Rb screen.

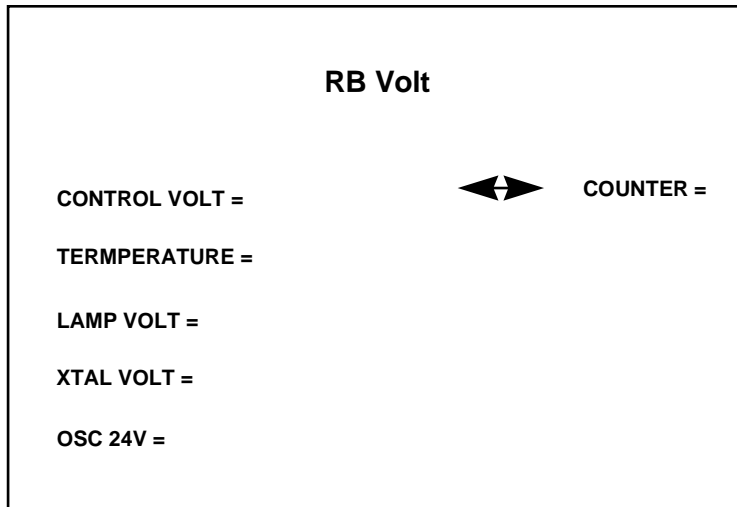


Figure 13: Rubidium (Ref 0) Voltage screen.

### 7.3 Viewing the Ref 1 Crystal Electrical Characteristics

1. Using the procedures outlined in Section 4.4, connect the laptop computer to the RFTG so that the Ref 1 data is displayed in the NORMAL screen.
2. Switch the toggle switch to the Ref 0 position.

**WARNING! Do NOT proceed until step 2 has been successfully completed. Failure to do so could bring down the CDMA cell.**

3. Under the **System XO** menu, select the **Voltages XO** menu item (see Figure 14).
4. Figure 15 shows that the screen will change to.

There are two fields that displayed on this screen that are of interest. The first is the *Control Voltage*. As in the case with the Ref 0 module, the control voltage is the voltage across the Crystal oscillator which control the oscillator output frequency. The control voltage should be between 2.2 and 2.8 volts. The *Ant. Feed* field displays the current drawn by the GPS antenna. Depending on the amplifier gain of the GPS antenna *Ant. Feed* current will vary. Table 13 shows the *Nominal* current drawn by antennas of various gains.

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
		<b>Voltages XO</b> Correction Data XO Correction History XO Additional Status XO NVM Error Storage XO Request Cable Delay XO Request WarmUp Time XO Request Delta APE Rqst Constant APE Rqst APE 2 Rqst APE Rqst Delta Temp Rqst Hardware Version Rqst Avg Sample Rqst Freq Corr Schedule					

Figure 14: Requesting the Voltages XO screen.

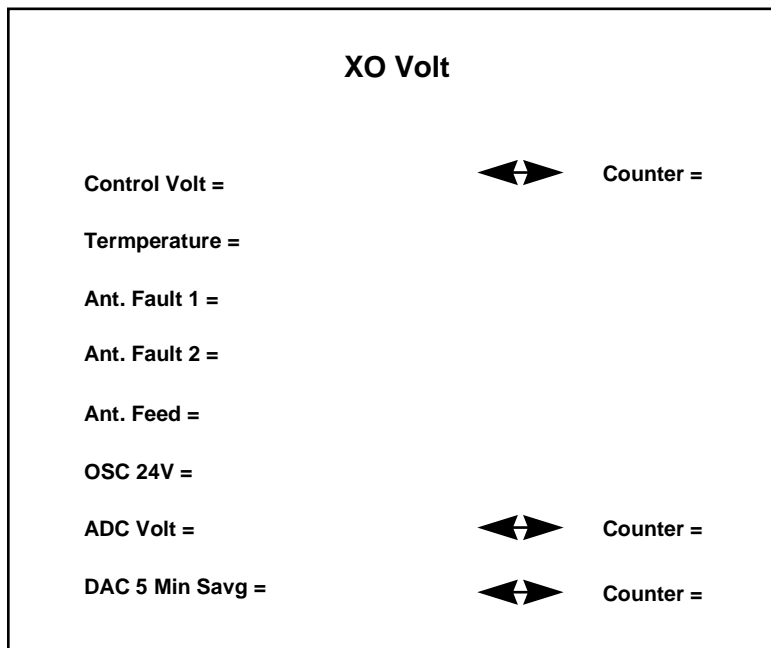


Figure 15: Electrical characteristics of the Ref 1 (Crystal) module.

Antenna List number	Gain factor	Nominal current
L112	26 ± 3 dB	37 mA
L116	40 ± 4 dB	46 mA
L10A	50 ± 4 dB	37 mA

Table 13: Current drawn from antennas of various gains.

## 8. Hard and Soft Resets

When trouble shooting the RFTG or hot swapping modules (hot swapping is described in Section 9), there are occasions when the RFTG needs to be reset. There are two ways of accomplishing this. The easiest way is to simply shut the power to the RFTG and then turn it back on. If the RFTG is implemented in an active cell, it is possible to reset the RFTG by shutting down power one module at a time. In this way, the timing signals to the RFTG are maintained and the CDMA frame can remain active. However, there is a way of resetting the RFTG which reboots the microprocessor and clears all RAM. This form of reset, which is termed *soft reset* is accomplished using the Diagnostic Software. Keep in mind that the *soft resets* only work with RFTG L1A and L1B. The soft reset commands to **DO NOT** work with RFTG L1.

**Warning: It is not recommended that the RFTG be reset unless the user is following the explicit instructions contained in the Trouble-Shooting section of this document. Failure to do so will, in all likelihood, bring down both the CDMA and AMPS frames.**

### 8.1 Resetting the Ref 0 (Rubidium) Module (L012A)

In this subsection, the method of resetting the Ref 0 module is discussed. It is assumed here that the RFTG is providing timing to an active cell. The module must be version L102A for this process to work. The process for resetting L102 is described at the end of this section.

1. Switch the toggle switch to the Ref 1 position. Verify that the green *On* light on the Ref 1 side is lit.
2. Using the techniques described in Section 4.4 connect the RFTG to the laptop computer and set the COM ports so that the Ref 0 data is displayed in the NORMAL screen.
3. Under the Control menu select the **Reset CPU Rb** menu item (see Figure 16)

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
				Replace Rb Set Position XO Set Position RB-XO Set Cable Delay Rb Set Cable Delay XO Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO <b>Reset CPU Rb</b> Reset CPU XO			

Figure 16: Resetting the Ref 0 (Rubidium) module.

4. The *15 MHz Alarm* light on the Ref 0 side should be lit.
5. Under the Control menu select the Replace Rb command (see Figure 17). A pop-up window will appear. Click on **OK**.

<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
				<b>Replace Rb</b> Set Position XO Set Position RB-XO Set Cable Delay Rb Set Cable Delay XO Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO <b>Reset CPU Rb</b> Reset CPU XO			

Figure 17: Initiating the *Replace Rb* command.

6. Wait for approximately eight minutes. If the data in the NORMAL screen has not begun to update, select under the **Mode** menu, the **Normal** menu item. The data in the NORMAL screen should now be updating.
7. After about 15 minutes (from the time the **Reset CPU Rb** command was initiated), the red *15 MHz Alarm* light should extinguish.

## 8.2 Resetting the Ref 1 (Crystal) Module.

In this subsection, the method of resetting the Ref 1 module is discussed. It is assumed here that the RFTG is providing timing to an active cell. Remember, the *soft reset* commands will only work in L104A and L104B. The procedure for resetting the L104 module is described at the end of this section.

1. Switch the toggle switch to the Ref 0 position. Verify that the green *On* light on the Ref 0 side is lit.
2. Using the techniques described in Section 4.4 connect the RFTG to the laptop computer and set the COM ports so that the Ref 1 data is displayed in the NORMAL screen.
3. Under the Control menu select the **Reset CPU XO** menu item (see Figure 18).
4. The *15 MHz Alarm* light on the Ref 1 side should be lit.
5. Wait for approximately eight minutes. If the data in the NORMAL screen has not begun to update, select under the Mode menu, the Normal menu item. The data in the NORMAL screen should now be updating.

- After about 17 minutes (from the time the **Reset CPU XO** command was initiated), the red *15 MHz Alarm* light should extinguish.

MODE	SYSTEM Rb	SYSTEM XO	GPS	CONTROL	TRAIM	EPR Rb	EPR XO
				Replace Rb Set Position XO Set Position RB-XO Set Cable Delay Rb Set Cable Delay XO Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO Reset CPU Rb <b>Reset CPU XO</b>			

Figure 18: Resetting the Ref 1 (Crystal) module.

### 8.3 Resetting Modules L102 and L104

As mentioned before, the Diagnostic Software was intended to be used with the RFTG L1A and L1B. If the RFTG is an L1, then a different approach is needed to reset the RFTG.

- Switch the toggle switch to the Ref 1 position.
- Verify that the Ref 1 green *On* light is lit.
- Shut power to the Ref 0 module by switching circuit breaker CB1 (at the top of the AIF frame) off.
- Wait a few seconds and turn circuit breaker CB1 back on. Verify that the Ref 0 red *15 MHz Alarm* light and the Ref 0 yellow *No GPS* lights are lit.
- Wait until the Ref 0 red *15 MHz Alarm* light extinguishes and the yellow *Stby* light is lit.
- Switch the toggle switch to the Ref 0 position.
- Verify that the Ref 0 green *On* light is lit.
- Shut power to the Ref 1 module by switching circuit breaker CB2 (at the top of the AIF frame) off.
- Wait a few seconds and turn circuit breaker CB2 back on. Verify that the Ref 1 red *15 MHz Alarm* light and the Ref 1 yellow *No GPS* lights are lit.
- Wait until the Ref 1 red *15 MHz Alarm* light extinguishes and the yellow *Stby* light is lit.

## 9. Hot-swapping Modules

There are times when it becomes necessary that one or both modules be swapped out. Normally, swapping out modules occurs when one module is defective or the RFTG needs to be upgraded (that is, upgrading from an L1 to an L1A or L1B or upgrading from an L1A to an L1B). In

addition, there may be times when the swapping of modules must be performed without interrupting service (this process is termed *Hot-swapping*). In this section, the precise procedure for hot-swapping modules is described. Note that in order to perform hot-swaps, the cell must be operating on Release 7.10 beta 02 build or later (b02Y07.10).

**Caution: It is very important that each step be successfully completed. Failure to do so, will in all likelihood bring down the CDMA frame.**

**Caution: If at any time while using the Diagnostic Software, the wrong menu item is chosen, IMMEDIATELY click on the Normal menu item in the Mode menu and continue with the procedure.**

### 9.1 Hot-swapping the Ref 0 (Rubidium) Module

1. Switch the toggle switch to the Ref 1 position. Verify that the Ref 0 yellow *Stby* light is lit and the Ref 1 green *On* is also lit.
2. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG0 connector.
3. Execute the Diagnostic Software program and set the COM ports so that the Ref 0 (Rubidium) data appears on the NORMAL screen.
4. Use the circuit breaker CB1 at the top front of the AIF frame to remove power from the RFTG REF 0 module.
5. Using a slot head screwdriver, remove the four screws surrounding the REF 0 module.
6. Carefully remove the REF 0 unit making sure not to disconnect any of the cabling in the center of the RFTG. It may be necessary to wiggle the unit from side to side while pulling.
7. Insert new REF 0 until a click (or snap) is heard and the unit is flush. **WARNING:** If the module jams do not use excessive force. Excessive force can break the connector at the back.
8. If the module is not quite flush with the shelf, pull back and try again.
9. Tighten the four screws surrounding the REF 0 unit.
10. Power up the REF 0 module by turning on CB 1. Verify that the yellow *NO GPS* light and the red *15 MHz Alarm* lights are on.
11. Verify, within ten minutes, that the data on the NORMAL screen is updating. If it is not, select the **Normal** menu item under the **Mode** menu. The data in the NORMAL screen should now be updating.
12. In the Control menu, select the Replace Rb menu item within 15 minutes from REF 0 power up (see Figure 19). This will bring up a confirmation window. Click **OK**.



<u>MODE</u>	<u>SYSTEM Rb</u>	<u>SYSTEM XO</u>	<u>GPS</u>	<u>CONTROL</u>	<u>TRAIM</u>	<u>EPR Rb</u>	<u>EPR XO</u>
				<b>Replace Rb</b> Set Position XO Set Position RB-XO Set Cable Delay Rb Set Cable Delay XO Set Cable Delay Rb-XO Enable CPU_Rb Disable CPU_Rb Enable CPU_XO Disable CPU_XO Reset CPU Rb Reset CPU XO			

Figure 19: Initiating the *Replace Rb* command.

13. If the length of the GPS antenna cable exceeds 100 ft, set the Cable Delay parameter for the Ref 0 side using the procedures discussed in Section 5.2.
14. Approximately 15 minutes from power up, the Ref 0 red *15 MHz Alarm* LED should extinguish and the yellow Ref 0 *Stby* LED should light.
15. 3 minutes later, the Ref 0 *No GPS* LED should extinguish.

**WARNING! Do NOT proceed until step 15 has been successfully completed. Failure to do so could bring down the CDMA cell.**

16. Select the **Normal** menu item in the **Mode** menu. Verify that the GPS time in the **NORMAL** screen is updating.

**WARNING! It is very important that step 16 be completed. Failure to do so WILL bring down the CDMA cell.**

## 9.2 Hot-swapping the Ref 1 (Crystal) Module

1. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG0 connector.
2. Execute the Diagnostic Software program and set the COM ports so that the Ref 0 (Rubidium) data appears on the **NORMAL** screen.
3. Verify that the Ref 0 (Rubidium) module is either in Warm-up mode or Locked to GPS.
4. Verify that the Ref 0 red *15 MHz Alarm* light is off.
5. If the unit is not in Warm-up or Locked to GPS or if the red *15 MHz Alarm* LED is lit then reset the Ref 0 module using the procedures described in Section 8.1.

Lucent Technologies Proprietary  
Use Pursuant to Company Instructions

6. Under the **Mode** menu, select the **Normal** menu item. The data in the NORMAL screen should be updating.

**Warning: It is very important that Steps 1-6 be completed successfully otherwise the CDMA and AMPS frames WILL be brought down.**

7. Switch the toggle switch to the Ref 0 position. Verify that the Ref 1 yellow *Stby* light is lit and the Ref 0 green *On* is also lit.
8. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG1 connector.
9. Execute the Diagnostic Software program and set the COM ports so that the Ref 1 (Crystal) data appears on the NORMAL screen.
10. Use the circuit breaker CB2 at the top front of the AIF frame to remove power from the RFTG REF 1 module.
11. Disconnect the GPS antenna cable from the Ref 1 module.
12. Using a slot head screwdriver, remove the four screws surrounding the REF 1 module.
13. Carefully remove the REF 1 unit making sure not to disconnect any of the cabling in the center of the RFTG. It may be necessary to wiggle the unit from side to side while pulling.
14. Insert new REF 1 until the unit is flush. WARNING: If the module jams do not use excessive force. Excessive force can break the connector at the back.
15. If the module is not quite flush with the shelf, pull back and try again.
16. Tighten the four screws surrounding the REF 1 unit.
17. Power up the REF 1 module by turning on CB 2. Verify that the yellow *NO GPS* light and the red *15 MHz Alarm* lights are on.
18. Verify, within ten minutes, that the data on the NORMAL screen is updating. If it is not, select the **Normal** menu item under the **Mode** menu. The data in the NORMAL screen should now be updating.
19. If the length of the GPS antenna cable exceeds 100 ft, set the Cable Delay parameter for the Ref 1 module using the procedures discussed in Section 5.2.
20. Approximately 16 minutes from power up, the Ref 1 red *15 MHz Alarm* LED should extinguish and the yellow Ref 1 *Stby* LED should light.
21. 3 minutes later, the Ref 1 *No GPS* LED should extinguish.

**WARNING! Do NOT proceed until step 21 has been successfully completed to avoid receiving unnecessary alarms at the MSC.**

22. Select the **Normal** menu item in the **Mode** menu. Verify that the GPS time in the NORMAL screen is updating.

**WARNING! It is very important that step 22 be completed. Failure to do so WILL bring down the CDMA cell.**

## 10. Trouble Shooting the RFTG

### 10.1 Introduction

This section discusses troubleshooting the RFTG. In many of these cases, the solution is to reset one or both modules. However, it is also important, before resetting the modules, to ascertain why the problem has occurred. This trouble shooting section should aid the user in ascertaining the problem. At the end of this section, there is a table that summarizes the Hardware Error Handler (HEH) codes that might be received at the Mobile Switching Center (MSC).

### 10.2 The RFTG Ref 1 Yellow *No GPS* Light is Flashing

As discussed in Section 7, The RFTG measures the current drawn by the GPS antenna. If this current falls below 10 mA, it issues an *Antenna Feed Fault* error and the Ref 1 yellow *No GPS* light begins to flash. There are two reasons why an Antenna Feed Fault would occur. The first (and most likely) reason is that the GPS antenna cable is not connected properly (or not connected at all) to the RFTG. In this case, the solution is simply to remove and carefully reconnect the GPS antenna cable to the RFTG making sure that the connectors are properly torqued.

The second cause of an Antenna Feed Fault Error is the antenna cable is faulty or the GPS antenna itself is faulty. If reconnecting the GPS antenna cable to the RFTG does not work then it may be necessary to replace the cable and/or the GPS antenna.

### 10.3 The RFTG yellow *NO GPS* lights are lit.

When the yellow *No GPS* lights are lit, it normally implies that the unit is flywheeling. That is, the unit is unable to track any GPS satellites. There are several potential reasons why this may be occurring. If the *No GPS* lights are lit do the following:

1. Using the procedures outlined in Section 4.4 connect the laptop computer to the RFTG so that the Ref 1 data is displayed in the NORMAL screen.
2. Verify that the Status field shows the unit to be Flywheeling. If it does not, then check whether the Status field shows the unit to be in Warm-up mode. If the unit is Warm-up mode, then wait up to 20 minutes for the unit to come out of this mode. At that time, the unit should lock to GPS.
3. Check the list numbers on the RFTG and the Ref 0 and Ref 1 modules. Depending on the list number of the RFTG, the Ref 0 and Ref1 modules should have the following list numbers (Table 14):

RFTG Shelf List Number	Ref 0 Module List Number	Ref 1 Module List Number
L1	102	104
L1A	102A	104A
L1B	<b>102A</b>	104B

Table 14: List numbers for various versions of the RFTG.

Note, that in the RFTG L1B, the Ref 0 module retains its list number as **102A**.

6. It is important that versions of the RFTG and the modules follow Table 14. Combinations other than those shown in Table 14 are not valid. Do not proceed until the versions of the RFTG and the modules are consistent with Table 14.
7. Depending on the versions of the modules, a different course of action is required.

### 10.3.1 Correcting for Flywheel Conditions on the RFTG L1

The RFTG L1 is the first model of the RFTG. The GPS receiver board does not use the T-RAIM algorithm.

1. The Diagnostic Software should already be in the NORMAL screen and should be displaying the data of the Ref 1 module (the Module field should read XO). If it is not, click on **Normal** under the **Mode** menu. Verify that the data shown in the NORMAL screen is for Ref 1(Crystal).
2. Switch the toggle switch to the Ref 1 position. Verify that the Ref 1 green *On* light is lit.
3. Exit the Diagnostic Software and disconnect the laptop computer.
4. Disconnect the power to the **Ref 0** (Rubidium) module by turning of circuit breaker CB1 at the top of the AIF frame. Wait a few seconds and reestablish power to the Ref 0 module by switching circuit breaker CB1 to the on position.
5. Verify that the Ref 0 red *15 MHz Alarm* LED and the yellow *Stby* LED are lit.

**WARNING! It is very important that the Ref 0 module is power cycled first otherwise both the CDMA and AMPS systems will be brought down.**

6. Verify within 15 minutes of power up that the REF 0 red *15 MHz Alarm* LED has gone off and the yellow *Stby* LED is lit.
7. Switch the toggle switch to the REF 0 position. Verify that the Ref 0 green *On* light is lit.
8. Disconnect the power to the **Ref 1** (Crystal) module by turning of circuit breaker CB2 at the top of the AIF frame. Wait a few seconds and reestablish power to the Ref 1 module by switching circuit breaker CB0 to the on position.
9. Verify that the Ref 1 red *15 MHz Alarm* LED and the yellow *Stby* LED are lit.

10. Verify within 15 minutes of power up that the REF 1 red *15 MHz Alarm* LED has gone off and the yellow *Stby* LED is lit.
11. At this time, the Diagnostic Software should already be in the NORMAL screen and displaying the data for Ref 1.
12. The Status field should show that the REF 1 is *Locked to GPS*.
13. Verify that the yellow *NO GPS* LEDs on both sides have gone off.

### 10.3.2 Correcting for Flywheel Conditions on the RFTG L1A

The RFTG L1A is the upgraded RFTG with new firmware and a new GPS receiver board that employs the T-RAIM algorithm described earlier. The Diagnostic Software is optimized for this version of firmware.

1. Using the procedures outlined in Section 4.4 connect the laptop computer to the RFTG so that the Ref 1 data is displayed in the NORMAL screen.
2. Switch the toggle switch to the Ref 0 position.
3. Using the procedures outlined in Section 7.3 view the electrical characteristics of the Ref 1 module. Verify that the control voltage across the oscillator is within specifications. Verify that the current drawn by the antenna is within specifications. If it is not, the Ref 1 module should be hot-swapped.
4. If the electrical characteristics of the oscillator and the GPS antenna are within specifications, select the **Normal** menu item in the **Mode** menu.

If the above steps do not show any problems, then it is possible that the GPS antenna does not conform to the *Lucent Technologies CDMA GPS Antenna Installation Guidelines*. Verify that the antenna installation does conform to the guidelines.

Using the procedures discussed in the Sections 8.1 and 8.2, *soft reset* the Ref 0 module. When the Ref 0 module has finished warming up, *soft reset* the Ref 1 module. In most cases, this will take the RFTG out of flywheel.

### 10.3.3 Correcting for Flywheel Conditions on the RFTG L1B

The RFTG L1B contains enhancements that improve GPS reception and reduce flywheeling. If the RFTG L1B is in flywheel mode, check the electrical characteristics of the Ref 1 module:

1. Using the procedures outlined in Section 4.4 connect the laptop computer to the RFTG so that the Ref 1 data is displayed in the NORMAL screen.
2. Switch the toggle switch to the Ref 0 position.
3. Using the procedures outlined in Section 7.3 view the electrical characteristics of the Ref 1 module.
4. Verify that the control voltage across the oscillator is within specifications. Verify that the voltage across and the currents drawn by the antenna are within specifications. If it is not, the Ref 1 module should be hot-swapped.

Lucent Technologies Proprietary  
Use Pursuant to Company Instructions

5. If the electrical characteristics of the oscillator and the GPS antenna are within specifications, select the **Normal** menu item in the **Mode** menu.

If the above steps do not show any problems, then it is possible that the GPS antenna does not conform to the *Lucent Technologies CDMA GPS Antenna Installation Guidelines*. Verify that the antenna installation does conform to the guidelines.

Using the procedures discussed in the Sections 8.1 and 8.2, *soft reset* the Ref 0 module. When the Ref 0 module has finished warming up, *soft reset* the Ref 1 module. In most cases, this will take the RFTG out of flywheel.

#### **10.4 Recovery from “GPS RX Fail” message procedure.**

It may happen that the NORMAL screen of diagnostics software reports a “GPS RX Fail” message. This could be due to two reasons: RFTG internal timing conflict or real failure of the GPS receiver inside the Ref 1 module.

##### 10.4.1 GPS RX Fail Message due to the RFTG timing conflict.

In certain rare occasions XO L104A and L104B can have internal timing problems receiving GPS messages from the receiver. In this case the RFTG times out and reports “GPS RX Fail” message. The problem can happen either in warm-up or fly-wheel modes only.

Warm-up.

1. Connect a laptop equipped with diagnostics SW to the RFTG.
2. Before starting the diagnostic program make sure the RFTG switch is in ‘REF 0’ position.
3. Start the diagnostics SW, and place Ref 1 module in ‘Normal’ mode.
4. Verify that the error message in the FAIL CODE field is ‘GPS RX Fail’.
5. Place Ref 1 module in ‘Diagnostic’ mode
6. Wait for two minutes and verify that the ‘GPS RX Fail’ message is gone.
7. Wait for a minimum of 2 more minutes, go to GPS | Status menu and verify that at least 4 satellites are tracked and used for position fix.
8. Restore Ref 1 to the ‘Normal’ mode,
9. Flip the select switch to ‘REF 1’
10. Start the diagnostics SW, and place Ref 0 module in ‘Normal’ mode.
11. Verify that the error message in the FAIL CODE field is ‘GPS RX Fail’.
12. Place the Ref 0 module in ‘Diagnostic’ mode
13. Wait for two minutes and verify that the ‘GPS RX Fail’ message is gone.
14. Restore Ref 0 to the ‘Normal’ mode,
15. Wait for the RFTG to come out of ‘warm-up’ mode and lock to GPS. Make sure that green *ON* LED on REF 0 and yellow *STBY* LED on Ref 1 are lit.

##### 10.4.2 Fly-wheel.

If the 'GPS RX Fail' message shows up in the fly-wheel mode, the problem would clear up once the GPS RX re-acquires the satellites and GPS lock. To resolve no GPS problem is to carry the procedures outlined in Section 10.3.

#### 10.4.3 GPS RX Fail message due to a failed receiver.

If GPS RX Fail message is not fixed by the procedure of the preceding sections, then there must be either an RFTG hardware or GPS RX failure problem. The XO unit must be replaced.

### 10.5 The Red *15 MHz Alarm* Light is On

There are two cases in which the red *15 MHz Alarm* light of a module would illuminate. The first is that the module is in warm-up mode. The second is that the module has experienced a problem and the unit has failed. If both *15 MHz* alarm lights are on, then either the entire unit is in warm-up or the entire unit has failed. In either case, the RFTG is not producing reference signals to both the CDMA and AMPS systems.

#### 10.5.1 Only the Ref 0 Red *15 MHz Alarm* light is on

The first step is to check whether the Ref 0 module is in warm-up mode.

1. Switch the toggle switch to the Ref 1 position. Verify that the Ref 1 green *On* is lit.
2. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG0 connector.
3. Execute the Diagnostic Software program and set the COM ports so that the Ref 0 (Rubidium) data appears on the NORMAL screen.
4. In the Status field of the NORMAL screen, check whether the unit is warming up (the field should read *Warm-up*). If the unit is warming up, issue the *Replace Rb* command (see Figure 19 on page 33). This will bring up a confirmation window. Click **OK**. The unit should come out of flywheeling within 15 minutes and the red *15 MHz Alarm* light will extinguish.
5. Using the procedures discussed in Section 8.1 (on Page 29) *soft reset* the Ref 0 module.
6. When the module comes out of warm-up, the Status field in the NORMAL screen should read *Locked to GPS*. Switch the toggle switch back to Ref 0, exit the Diagnostic Software and disconnect the laptop.
7. If resetting the module does not work replace the module following the procedures outlined in Section 9.1.

#### 10.5.2 Only the Ref 1 Red *15 MHz Alarm* light is on

The first step is to check whether the Ref 1 module is in warm-up mode.

1. Switch the toggle switch to the Ref 0 position. Verify that the Ref 0 green *On* is lit.
2. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG1 connector.
3. Execute the Diagnostic Software program and set the COM ports so that the Ref 1 (Crystal) data appears on the NORMAL screen.
4. In the Status field of the NORMAL screen, check whether the unit is warming up (the field should read *Warm-up*). If the unit is warming up, the unit should come out of flywheel mode within 16 minutes, and the red *15 MHz Alarm* light will extinguish.
5. Using the procedures discussed in Section 8.2 (on Page 30) *soft reset* the Ref 1 module. When the module comes out of warm-up, the Status field in the NORMAL screen should read *Locked to GPS*. Switch the toggle switch back to Ref 1, exit the Diagnostic Software and disconnect the laptop.
6. If resetting the module does not work, replace the module following the procedures in Section 9.2.

### 10.5.3 Both Red *15 MHz Alarm* Lights are Lit

If both *15 MHz Alarm* lights are lit then the entire unit is in warm-up or the entire unit has failed. In either case, the CDMA and AMPS systems are not operational.

1. Switch the toggle switch to the Ref 0 position. Verify that the Ref 0 green *On* is lit.
2. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG1 connector.
3. Execute the Diagnostic Software program and set the COM ports so that the Ref 1 (Crystal) data appears on the NORMAL screen.
4. In the Status field of the NORMAL screen, check whether the unit is warming up (the field should read *Warm-up*). If the unit is warming up, the unit should come out of flywheel mode within 16 minutes, and the red *15 MHz Alarm* light will extinguish. In addition, when the Ref 1 module comes out of warm-up, the Ref 0 red *15 MHz Alarm* light should also extinguish.
5. If the unit is not in warm-up but shows a unit failure, make a note of the failure shown in the *Fail Code* of the NORMAL screen.
6. Switch the toggle switch to the Ref 1 position. Verify that the Ref 1 green *On* is lit.
7. Using the procedures outlined in Section 4.4 connect the laptop computer using the RFTG0 connector.
8. Execute the Diagnostic Software program and set the COM ports so that the Ref 0 (Rubidium) data appears on the NORMAL screen.
9. Reset the entire unit by simultaneously shutting of circuit breakers CB1 and CB2. Wait a few seconds, and then simultaneously turn on circuit breakers CB1 and CB2. Within 17 minutes, both red *15 MHz Alarm* lights should extinguish and the unit should be Locked to GPS (check the Status field in the NORMAL screen in either Ref 0 or Ref 1).



## 10.6 Hardware Error Handler (HEH)

An alternative way to diagnose a problem is to analyze the messages printed out by the **Read Only Printout** (ROP) which is printed out at the MSC. The ROP data for the RFTG has the following format:

```

REPT Cell #, HEH, CAT #
PID: OS= CM, N/A, 0
Error Type CMRFTGBRDE
XX XX XX XX AA BB CC DD EE FF
GG HH II JJ XX XX XX XX XX XX
XX XX XX XX
  
```

Table 15: Format of RFTG ROP data.

Each pair of characters (e.g. AA) are two ASCII characters. The XX characters are not pertinent. The AA indicates whether the Ref 0 module is active or not.

ASCII Pair AA	Definition
00	The message is from Ref 0 and Ref 0 is active
01	The message is from Ref 0 and Ref 0 is standby

Table 16: Definition of the AA ASCII Pair. AA refers only to the Ref 0 module.

ASCII pair BB represents the state that the Ref 0 module is in.

ASCII Pair BB	Definition
00	Module is in warm-up mode
01	Module is locked to GPS
02	Module is Flywheeling
03	Module has failed

Table 17: Definition of the BB ASCII pair.

ASCII pairs CC and DD are error codes (1 byte per pair). CC is the first error byte (referred to as error byte 1) and DD is the second error byte (referred to as error byte 2). The error bytes are in Hexadecimal format and need to be converted to their equivalent binary representation. The ASCII pair EE refers to the number of hours that the unit has been in that state.

HEX	Binary	HEX	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

Table 18: Conversion from Hexadecimal to Binary

Using Table 18 convert each ASCII pair to its binary format.

**Example:** Suppose that the ASCII pair is 2C:

According to Table 18, 2 in binary format is 0010 and C is 1100.

Therefore: 2C in binary format is 00101100

Once the error bytes have been converted into binary format, the appropriate error and its severity can be derived from Table 19. In the *Error Bit* column, the bytes and bits are referenced as YZ where Y is the error byte number (either 1 or 2) and Z is the bit. The error bits follow the format shown Figure 20. Therefore 1.7 refers to Error Byte 1, bit 7 (*i.e.*, 10000000). The severity of the error is also derived from Table 19.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-------	-------	-------	-------	-------	-------	-------	-------

Figure 20: Sequence of error bits in each error byte.

**Example:** Suppose that the ASCII pair for Error Byte 1 is 08. Using Table 18 the Error Byte is 00001000. In this case, Bit 3 is high. This would refer to 1.3 in Table 19. Therefore, the Error Byte corresponds to a 15 MHz failure. The severity of this error depends on what state Ref 0 is in. Recall that the state of the Ref 0 module is determined by the ASCII pair BB and is translated using Table 17. Suppose that the state of the Ref 0 module is Fail, then using Table 19, it can be determined that the severity of the Ref 0 error is Critical (see shaded region of Table 19).

Ref 0 Alarms						
BYTE CC		STATE REPRESENTED BY BYTE BB				
Error bit	Error Description	Locked	Warm-up	Fly-wheel	Fail	Comments
1.7	Warm-up Failure	normal	CRITICAL	normal	CRITICAL	
1.6	Ant. feed fault	X	X	X	X	X - N/A,
1.5	1PPS > Hi Threshold	normal	CRITICAL	normal	CRITICAL	
1.4	1PPS Missing	normal	CRITICAL	normal	CRITICAL	
1.3	15 MHz Fail	normal	CRITICAL	normal	CRITICAL	
1.2	RAM Fail	normal	CRITICAL	normal	CRITICAL	
1.1	ROM Fail	normal	CRITICAL	normal	CRITICAL	
1.0	OSC Maint. Req'd	MINOR	CRITICAL	normal	CRITICAL	
BYTE DD						
2.7	Delta Temp. Exceeded	normal	CRITICAL	1-8 hrs - MAJOR >8 hrs - CRITICAL	CRITICAL	
2.6	1PPS Corr. > 2 uSec	MINOR	CRITICAL	normal	CRITICAL	
2.5	High Temp. Exceeded	normal	CRITICAL	1-8 hrs - MAJOR >8 hrs - CRITICAL	CRITICAL	
2.4	Fly-wheel > 8 hours	normal	CRITICAL	normal	*8-24hrs- MAJOR >24hrs-CRITICAL	* L102 only
2.3	OSC PLL Lock Fail	x	x	x	x	
2.2	reserved	x	x	x	x	
2.1	OSC Lock Fail	normal	CRITICAL	normal	CRITICAL	
2.0	GPS RX Fail	MINOR	CRITICAL	normal	CRITICAL	
BYTE EE	(HEX VALUE REPRESENTS # OF HOURS IN THE CURRENT STATE)	X	X	1-8 hrs = MINOR 8-24 hrs = MAJOR >24hrs = CRITICAL	X	X = N/A

Table 19: Definition and severity of error bytes for the Ref 0 module.

Severity	Definition
Normal	Module is operating normally.
Minor	Module is experiencing non-service affecting problem.
Major	Module is experiencing a problem nearing service affecting.
Critical	Module has failed and is not producing any timing signals.

Table 20: Definition of severity classes.

The same procedures are used to decode the ASCII pairs for the Ref 1. The FF ASCII pair represents where the message is coming from (in this case, the message is coming from Ref 1) and the GG ASCII pair represents the state that the Ref 1 module is in. The HH and II ASCII pairs are the Hexadecimal representation of Error Byte 1 and Error Byte 2 of the Ref 1 module. The JJ is the Hexadecimal representation of the number of hours that the Ref 1 module has been in that state.

<b>Ref 1 Alarms</b>						
<b>BYTE HH</b>		<b>STATE REPRESENTED BY BYTE GG</b>				
<b>Error bit</b>	<b>Error Description</b>	<b>Locked</b>	<b>Warm-up</b>	<b>Fly-wheel</b>	<b>Fail</b>	<b>Comments</b>
1.7	Warm-up Failure	normal	CRITICAL	normal	CRITICAL	
1.6	Ant. feed fault	normal	CRITICAL	normal	CRITICAL	
1.5	1PPS > Hi. Threshold	normal	CRITICAL	normal	CRITICAL	
1.4	1PPS Missing	normal	CRITICAL	normal	CRITICAL	
1.3	15 MHz Fail	normal	CRITICAL	normal	CRITICAL	
1.2	RAM Fail	normal	CRITICAL	normal	CRITICAL	
1.1	ROM Fail	normal	CRITICAL	normal	CRITICAL	
1.0	OSC Maint. Req'd	MINOR	CRITICAL	normal	CRITICAL	
<b>BYTE II</b>						
2.7	Delta Temp. Exceeded	normal	CRITICAL	CRITICAL	CRITICAL	
2.6	1PPS Corr. > 2 uSec	MINOR	CRITICAL	normal	CRITICAL	
2.5	High Temp. Exceeded	normal	CRITICAL	CRITICAL	CRITICAL	
2.4	Fly-wheel > 8 hours	normal	CRITICAL	normal	CRITICAL	
2.3	OSC PLL Lock Fail	normal	CRITICAL	normal	CRITICAL	
2.2	reserved	X	X	X	X	X = N/A
2.1	OSC Lock Fail	normal	CRITICAL	normal	CRITICAL	
2.0	GPS RX Fail	MINOR	CRITICAL	normal	CRITICAL	
<b>BYTE JJ</b>	(HEX VALUE REPRESENTS # OF HOURS IN THE CURRENT STATE)	X	X	1-4 hrs = MINOR 4 hrs = CRITICAL	X	X = N/A

Table 21: Definition and severity of the Ref 1 error bytes.

The resulting RFTG alarm status shown on the MCRT screen at the MSC (Mobile Switching Center) is summarized in Table 22.

Ref 0 State	Ref 1 State	RFTG Status (MCRT screen)
Normal	Normal	Normal
Normal	Minor	Minor
Normal	Major	Minor
Normal	Critical	Minor
Minor	Normal	Minor
Minor	Minor	Minor
Minor	Major	Minor
Minor	Critical	Minor
Major	Normal	Minor
Major	Minor	Minor
Major	Major	Major
Major	Critical	Major
Critical	Normal	Minor
Critical	Minor	Minor
Critical	Major	Major
Critical	Critical	Critical

Table 22: RFTG status displayed on MCRT screen given Alarm status of Ref 0 and Ref 1.

## 11. References

1. G. C. Stocker and D. Palaski, "CDMA GPS Antenna Installation Guidelines Issue 1.0," Lucent Technologies Sept. 27, 1996.

## 12. Index

<i>I</i>		<i>L</i>	
12 hours .....	8	LEDs.....	6
15 MHz Alarm .....	39	<b>List of Figures</b> .....	4
<i>A</i>		<b>List of Tables</b> .....	5
<b>A/D Bits</b> .....	12	<i>Locked to GPS</i> .....	10
<b>a:install</b> .....	12	<i>M</i>	
<i>Acquiring Sats</i> .....	25	MESSAGE .....	15
almanac.....	24	<b>MODE</b> .....	12
<i>Ant. Feed</i> .....	27	<i>N</i>	
antenna port .....	8	NAVSTAR .....	7
ASCII string .....	15	<i>NO GPS</i> .....	35
<i>B</i>		North/South .....	21
base 60 notation.....	20	<i>Number of Tracking Sats</i> .....	24
<i>C</i>		<i>Number of Visible Sats</i> .....	24
<i>Cable Delay</i> .....	18	<i>P</i>	
Character Position .....	16	PCMCIA.....	12
<i>CMDA GPS Antenna Installation Guidelines</i> ...	37, 38	position .....	8
<i>Control Voltage</i> .....	26	<i>Position Hold</i> .....	25
<i>D</i>		<i>Q</i>	
DB15 .....	12	Quatech card.....	12
Diagnostic Software .....	6, 11	<i>R</i>	
<i>disciplined.</i> .....	8	<b>Read Only Printout</b> .....	41
DMS .....	20	<b>Ref 0 Alarms</b> .....	43, 44
<i>E</i>		<b>Reset CPU Rb</b> .....	29, 30
East/West.....	21	<b>Reset CPU XO</b> .....	30
EPLD TIME .....	15	RFTG.....	6
<b>Error bit</b> .....	43	RFTG.EXE.....	12
error byte .....	41	ROP .....	41
<i>F</i>		RS-422.....	12
FAIL CODE .....	15	<i>S</i>	
floppy disk.....	11	<i>Satellite ID</i> .....	25
<i>flywheeling</i> .....	9	Series II CDMA.....	6
<i>G</i>		<b>Set Cable Delay Rb</b> .....	18
Global Position System .....	7	<b>Set Cable Delay XO</b> .....	20
<i>H</i>		<b>Set Comm Port</b> .....	14
Hardware Requirements .....	11	<b>Set Configuration</b> .....	12
horizon.....	8	<b>Set Coordinates</b> .....	11
		<b>Set Position RB-XO</b> .....	21
		<i>Signal Strength</i> .....	25
		STATUS field.....	14
		<b>System Rb</b> .....	25

<b>System XO</b> .....	27
<i>T</i>	
Trouble Shooting the RFTG.....	35
<i>U</i>	
<i>Unit Failed</i> .....	15
<i>Using for Fix</i> .....	25
UTC.....	7

<i>V</i>	
<b>Voltages Rb</b> .....	25
<b>Voltages XO</b> .....	27
<i>W</i>	
Windows95.....	12