Cs4000 User Guide

Cs4000 User Guide
Installation, Configuration, and Operation
Part #: 14994-201, Rev. D., September 2006

NOTICE

WARRANTY

Symmetricom, Inc. warrants for one year after delivery to the original purchaser of any product manufactured by Symmetricom, that it shall be free of defects in material and workmanship. Obligation under this warranty shall be limited to repair or replacement, at Symmetricom's discretion, of any product or part thereof that has been returned by the original purchaser with transportation prepaid, and upon examination by Symmetricom, is found to be defective. Symmetricom assumes no responsibility for loss or damage to equipment being returned for repair or replacement under the terms of this warranty.

For this warranty to be effective, the purchaser agrees that the equipment will be properly installed and maintained. Equipment which, upon examination by Symmetricom, requires repair or replacement of parts thereof as a result of improper installation, misuse, unauthorized alterations or repairs, or user negligence, such repairs or replacement of parts thereof will be made at cost.

Symmetricom makes no representation or warranty of any kind, either expressed or implied, with respect to equipment operation and procedures. Any action that the user may take in reliance upon the operation or accuracy of this equipment shall be taken solely upon the user's own responsibility and risk.

Symmetricom shall not be liable for consequential damages to purchaser, user, or any others resulting from the possession or use of this equipment.

Prior to return of a product under terms of this warranty, Symmetricom, Inc., is to be notified. Notification is to include the model number and serial number of the product and full details of the problem.

AMENDMENT NOTICE

Symmetricom, Inc. makes every attempt to provide up-to-date manuals with the associated equipment. Occasionally, changes are made to the equipment wherein it is necessary to provide amendments to the manual. If any amendments are provided for this manual they are printed on paper stock other than white and will be found at the rear of this manual.

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Chapter 1 - Introduction

This *User Guide* contains information about installing, operating, and maintaining the Symmetricom Cs4000 Cesium Frequency Standard.

By international agreement, at the 1967 *Conférence Générale des Poids et Mesures*, the *Système Internationale* (SI) unit of time is defined as follows:

> “The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.”

The function of the Cs4000 is to realize this definition in a continuous and reliable manner, providing the user with convenient output signals with the highest possible stability and accuracy. The Cs4000 represents the state-of-the-art in cesium beam technology, both in the design of the physics package as well as the electronic and microprocessor control systems.

Comprehensive instrument control and monitoring is provided using Symmetricom **Monitor3** software, which runs on a Microsoft Windows PC that is connected to the Cs4000’s RS-232 port.

Additionally, the optional LCD touchscreen located on the front panel provides a comprehensive GUI interface for control and monitoring of the Cs4000’s function.

Furthermore, the status of Cs4000’s key parameters and settings are displayed on a web page that is available from the instrument’s optional network port. For security reasons, the web page is read-only and cannot be used to configure the instrument.

The Cs4000 is designed for use in laboratory environments for timing and test and measurement applications. The standard output configuration includes:

- (1x) 100 kHz sine wave output
- (1x) 1 MHz sine wave output
- (2x) 5 MHz sine wave outputs
- (2x) 10 MHz sine wave outputs
- (3x) 1 PPS Out, (2x) Rear; (1x) Front
- (2x) 1 PPS synchronization input, (1x) Rear; (1x) Front

Other standard features are:

- AC (85-264 VAC) & DC (36-75 VDC) Inputs
- Remote Monitoring and Control
- 30 Minute Warm-Up to Full Specifications

Optional features include:

- LCD Touchscreen Display, Controller, and Ethernet Port (“DCC”)
- High Performance Tube
- T1 and E1 Telecommunications Outputs
- Internal Battery Back-Up
- 24 VDC Input Power (22-36 VDC)

1.1 Who Should Read This User Guide

This *User Guide* is designed for the following categories of users:

Systems Engineers **–** Chapters **2** and **6** provide an overview of the product, options, and theory of operation. Cross-references in these sections direct readers to detailed system configuration information in Chapter **4**. Chapter **5** provides information about product ordering, shipping, and storage.

Installation Engineers – Chapter **3** provides installation information and procedures. Chapter **4** and **Appendix B** provide specific configuration and operation information to ensure proper operation, or to modify the systems configuration.

Maintenance Engineers – Chapter **5** provides preventive and corrective maintenance guidelines. Chapter **6** also provides procedures for diagnosing and troubleshooting fault indications and alarms.

Certain sections, particularly Chapters **1** and **2** are intended for non-technical audiences. Others, such as Chapter **3** through **Appendix A,** contain instructions to be performed by qualified personnel only.

1.2 About This User Guide

This *User Guide* is a reference for the Cs4000 Cesium Frequency Standard. It contains an introduction to the Cs4000, system and configuration specifications, and procedures for installation, power-up, operation, maintenance, and troubleshooting.

1.3 Typographical and Other Conventions

This *User Guide* uses the following conventions:

Acronyms and Abbreviations – Terms are spelled out the first time they appear this *User Guide*. Thereafter, only the acronym or abbreviation is used. The glossary defines the acronyms and abbreviations.

Revision Control – The title page lists the part number, revision, and printing date of this *User Guide*. Table 1-1 describes the typographical conventions that this *User* uses to distinguish between the different types of information according to how they are used.

Table 1 Typographical Conventions

When text appears this way…	**It means…**
Cs4000 User Guide	The title of a document.
CRITICAL PORT-A J1	An operating mode, alarm state, status, or chassis label.
Press the **Enter** key.	A named keyboard key as it appears on the keyboard. An explanation of the key's acronym or function immediately follows the first reference to the key, if required.
A *re-timing* application…	Emphasis on a word or term.
Symmetricom ***does not*** recommend…	Special emphasis on a key word or idea.

1.4 Warnings, Cautions, Recommendations, and Notes

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this User Guide. The types of information included in each are explained as follows:

WARNING…
Do not disregard warnings. They are installation operation, or maintenance procedures, practices, or statements that, if not strictly observed, may result in personal injury, loss of life, or equipment damage.

ELECTRICAL SHOCK HAZARD…
All electrical shock hazard warnings have this symbol. To avoid serious personal injury or dearth, do not disregard electrical shock warnings. They are installation, operation, or maintenance procedures, practices, or statements that, if not strictly observed, may result in personal injury or loss of life.

CAUTION…
Do not disregard cautions. They are installation, operation, or maintenance procedures, practices, conditions, or statements that, if not strictly observed, may result in damage to or destruction of equipment or may cause a long-term health hazard.

RECOMMENDATION…
Recommendations indicate manufacturer-tested methods or known functionality. They contain installation, operation, or maintenance procedures, practices, conditions, or statements that provide important information for achieving optimal results.

NOTE…
Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information that can make your task easier or increase your understanding.

Chapter 2 - Product Overview

The Symmetricom Cs4000 Cesium Frequency Standard is designed for high precision timing and frequency applications requiring high stability, low noise RF and 1 PPS reference signals.

The Cs4000 comes in a standard 19-inch wide rack mount housing. It is 5.22 inches (13.26 cm) high and weighs 45 lbs (20.4 kg). Refer to **Appendix A – Specifications** on page 42 for detailed performance specifications.

Figure 1 Cs4000 Front Panel w. Optional LCD Touchscreen (DCC Option)

Figure 2 Cs4000 Rear Panel w. Optional Ethernet Port (DCC Option)

2.1 Front Panel Items

The following items are available on the front panel:

- Power Indicator – Green LED indicates power applied to instrument
- Lock Indicator – Green LED indicates normal operation
- Alarm Indicator – Red LED indicates unit alarm condition
- 1 PPS Sync – BNC input to synchronize 1 PPS output to external source (50Ω)
- 1 PPS Out – BNC output 1 PPS (50Ω)
- RS-232 – DB9 Male DTE (see page 10 for pin out information)
- LCD Touchscreen (part of the optional DCC package):
    - Menus for configuring and monitoring the Cs4000
    - Time of Year and Time of Day
    - Alarm Indicator – Red LED indicates unit alarm condition
    - Lock Indicator – Green LED indicates normal operation
    - Power Indicator – Indicates AC, DC, or Battery (optional) power

On units that have the optional LCD touchscreen, the Power, Lock, and Alarm Indicator LED's are replaced by the touchscreen.

2.2 Rear Panel Items

The following items are available on the rear panel:

- 5 MHz (2X) – Type-N connector 5 MHz output (50Ω)
- 10 MHz (2X) – Type-N connector 10 MHz output (50Ω)
- 1 MHz – BNC 1 MHz output (50Ω)
- 100 kHz – BNC 100 kHz output (50Ω)
- 1 PPS Out (2X) – BNC 1 PPS output (50Ω)
- 1 PPS Sync – BNC input to synchronize 1 PPS output to external source (50Ω)
- Alarm – BNC open-collector TTL active low indicates alarm condition
- LAN –RG-45 Ethernet 10-Base-T (part of DCC/LCD Touchscreen option)
- AC Input
- DC Input
- Fuse holders F1, F2
- Fuse holder F3 on units with the battery back-up option

2.3 Monitor3 Software

The Cs4000's principal user interface is the Symmetricom **Monitor3** software application. **Monitor3** runs on PCs running the Microsoft Windows (Windows 95 or newer) and connects to the Cs4000 with a standard RS-232 null modem cable. In addition to providing comprehensive configuration and control of the Cs4000, **Monitor3** provides periodic monitoring of the instrument's state-of-health parameters and, optionally, logs data to disk for subsequent analysis. Monitor3 also provides logging of Alarm events to a log file for monitoring and troubleshooting purposes. **Monitor3** is not essential to operate the Cs4000 if there is no need to modify factory default parameters, adjust frequency or phase of outputs, or to monitor internal health parameters. In some applications, users may develop their own interface software for control and monitoring of the Cs4000. The RS-232 command structure and command list are documented on pages 46 - 48.

2.4 Power

External power is supplied by a standard AC power cord or by a DC power connection. The power hierarchy is as follows:

- If AC power is available, the unit operates from the AC power.
- If AC power is NOT available and DC power is available, the unit operates from the DC input.
- If AC and DC power become unavailable, and the optional internal battery is available, the unit operates from the battery.
- If both AC and DC are applied the Cs4000 will operate from AC.

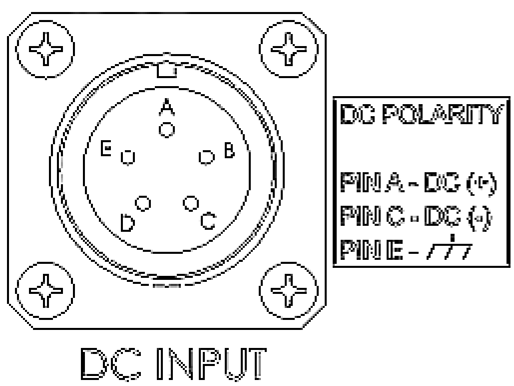

Figure 3 DC Input and Pin Assignments

2.5 Battery Power

The optional internal battery provides automatic backup power for if the external power becomes unavailable. Fully charged batteries typically provide 45 minutes of operation for the standard model, and 20 minutes of operation for units with the optional LCD touchscreen. The battery is charged from either AC or DC power, as available. It takes 16 hours to fully charge a discharged battery.

To disconnect the instrument from battery power, verify that the instrument is disconnected from external AC and DC power sources, and then remove the F3 battery fuse. At that point, the F3 battery fuse can be reinserted and the Cs4000 **will not start**.

The Cs4000 cannot start on battery power. The only way to restart the unit is to apply an external AC or DC power source.

WARNING… When packing and/or shipping units that have the battery back-up option, remove the battery fuse from the F3 fuse holder (located on the rear panel) and tape it to the rear panel for transport.

2.6 Optional Features

The **Cs4000** can be *ordered with* optional features that permit the system designer to specify the most cost-effective solution for a particular application. Optional features include:

- Enhanced Performance Cesium Beam Tube
- 24 VDC or 48 VDC auxiliary power input
- E1 and T1 Telecommunication Outputs
- DCC package, which includes:
  - LCD Touchscreen with Graphical User Interface
  - Cs4000 Web Interface (Status Information)
  - Ethernet Port (for access to the Cs4000 Web Interface)

Please note that while a T1 and an E1 card can be installed together, two cards *of the same type* (e.g., T1 & T1) cannot.

Refer to the following list of factory configurations and their corresponding part numbers:

- 14645-101 Std. Perf., 48 VDC Input
- 14645-102 Std. Perf., 24 VDC Input
- 14645-103 High Perf., 48 VDC Input
- 14645-104 High Perf., 24 VDC Input
- 14645-105 Std. Perf., 48 VDC Input, Battery
- 14645-106 Std. Perf., 24 VDC Input, Battery
- 14645-107 High Perf., 48 VDC Input, Battery
- 14645-108 High Perf., 24 VDC Input, Battery
- 14645-111 Std. Perf., 48 VDC Input, Battery, Display
- 14645-112 Std. Perf., 24 VDC Input, Battery, Display
- 14645-113 High Perf., 48 VDC Input, Battery, Display
- 14645-114 High Perf., 24 VDC Input, Battery, Display
- 14645-115 Std. Perf., 48 VDC Input, Battery, Display, E1
- 14645-116 Std. Perf., 24 VDC Input, Battery, Display, E1
- 14645-123 Std. Perf., 48 VDC Input, Battery, Display, T1
- 14645-124 Std. Perf., 24 VDC Input, Battery, Display, T1

Chapter 3 - Installation

This section provides unpacking instructions and installation procedures for the Cs4000 as well as warnings, cautions, notes, and recommendations that pertain to the procedures being performed. To prevent serious injury and/or equipment damage, do not ignore these safety, environmental, and operational messages.

NOTE…
If you encounter problems during any of the following procedures, contact Technical Support (see page 57).

3.1 Unpacking Instructions

CAUTION…
To avoid electrostatic discharge (ESD) damage to sensitive internal parts, observe proper ESD handling procedures.

1. Inspect the container for signs of damage. If the container appears to be damaged, notify both the carrier and the Symmetricom distributor. Retain the shipping container and packing material for the carrier to inspect.
2. Unpack all components in the shipping container.
3. Inventory, and set aside all items and paperwork that are included in the container.
4. Verify that the model and item number shown on the shipping list agrees with the model and item number on the equipment. The item number can be found on a label affixed to the rear panel. Contact the Symmetricom distributor if the model or item numbers do not match

CAUTION…
This instrument must be operating only as specified by the manufacturer. Use other than as specified may compromise the safety precautions of the system.

3.2 Environmental Conditions

When installing the instrument, consider the standard environmental factors (temperature, humidity, vibration, etc.) and the presence of magnetic fields that might affect the accuracy of the Cs4000. Avoid installing or using the instrument near large motors, generators, transformers, and other equipment that radiates strong AC or DC fields of 2-gauss or more.

3.3 Pre-Installation Checklist

Before installation, ensure that the following preparations are in place:

- The equipment rack is grounded and has power available
- Sufficient space is available in the equipment rack to accommodate the 3U Cs4000 as well as an additional 1U of space above and below the Cs4000 (for ventilation)
- Chassis rack supports or slides are available to support the Cs4000

3.4 Tools and Materials

The following is a list of recommended tools and materials **NOT** supplied by Symmetricom:

- Standard tool kit
- Rack supports or slide mounts
- Personal computer running Windows 95 or newer with one available serial port
- Null modem cable

3.5 Installing the Cs4000

The Cs4000 mounts in a standard 19-inch equipment rack. The Cs4000 side plates are drilled and tapped to accept chassis rack slides. The use of chassis rack slides or other means of support is necessary because of the weight and weight distribution of the instrument. The front panel occupies a height of 5.22” (3U).

1. Mount the Cs4000 in the desired location in the equipment rack using standard rack mount hardware.
2. For units that have the battery back-up option, install the proper fuse in the F3 fuse holder. (See page 44 or rear panel for fuse specifications.)
3. If available, apply AC power to the Cs4000 by installing the detachable power supply cord at the AC Input connection on the rear panel.
4. If available, apply DC power to **DC Input** (see page 44 for pin out information).
5. Observe that the POWER and ALARM front panel indicators are illuminated. Wait for the unit to stabilize and complete its initial acquisition sequence. This may take up to 30 minutes. When stabilized, the ALARM indicator turns off and the LOCK indicator illuminates. The ALARM relay is reset and all signal outputs are activated.

NOTE…
Applying power to the instrument initiates the warm-up and automatic lock acquisition sequence. During this time the ALARM relay is activated; all other signal outputs are not active. For units that have the DCC Option (GUI and Ethernet), the outputs are active upon power-up but do not meet the published performance parameters until the unit achieves "LOCK" status.

CAUTION…
To avoid damage to the system, access covers must not be removed, except by trained service personnel.

WARNING…
For continued protection against risk of fire, ensure that only the specified fuse type and rating are used. Fuse specifications are provided in section "7.1 Electrical Specifications" on page 42 and on the instrument's rear panel.

CAUTION…
The instrument is convection cooled. To prevent the instrument from overheating, leave one rack unit (1.75 in./4.44 cm) space above the unit for cooling.

CAUTION…
To prevent damage to the instrument during installation, ensure power is disconnected by removing the fuse from the rear panel. The fuse is the emergency disconnect for the device – there is no ON/OFF switch.

CAUTION…
To avoid electrostatic discharge (ESD) damage to components inside the instrument, observe proper ESD handling procedures.

3.6 Installing the Monitor3 Software

The **Monitor3** software application runs on any PC or laptop running Microsoft Windows 95 or newer. It requires less than 1 MB of disk space and one available serial (COM) port to connect to the Cs4000.

1. Locate the Monitor3 software on the CD-ROM provided in the shipping container. If unable to locate the CD-ROM, contact Symmetricom Customer Assistance (page 57) for a replacement CD-ROM.
2. Install the CD-ROM into the computer
3. Run the program setup.exe located on the CD-ROM by clicking the **Start** button, selecting **Run…**, and from the command line typing x:\setup.exe, where x is the drive letter of the installed CD-ROM.

This installs the Monitor3 application on your computer in, by default, the c:\Program Files\Symmetricom directory. A folder, named "Symmetricom" is added to your Start menu containing an icon for the Monitor3 application. An uninstall icon is also added so that you can easily remove the program in the future.

Table 2 RS-233 Port DB9 to DB25 Connector Pinout

DB9-F	DB25-F	Function
3	3	RX (Receive Data)
2	2	TX (Transmit Data)
5	7	GND (Signal Ground)

If you have a DB9 connector on your computer, refer to the following table for connector pinout information.

Table 3 RS-232 Port DB9 to DB9 Connector Pinout

DB9-F	DB9-F	Function
3	2	RX (Receive Data)
2	3	TX (Transmit Data)
5	7	GND (Signal Ground)

3.7 Establishing Communications

Connect a standard null modem cable from the PC's COM1 port to the Cs4000's RS-232 port on the front or rear panel.

On the PC, start the Monitor3 software (Programs->Symmetricom->Monitor3). Monitor3 starts (Figure 6) and automatically tries to establish a connection with the Cs4000 using the following RS-232 settings:

- Baud Rate = 9600
- Data bits = 7
- Parity = Odd
- Stop Bits = 2

If there's a problem with the physical connection or the RS-232 settings, the Monitor3 status bar may show "Unit Not Responding" in its lower left corner. Monitor3 periodically attempts to re-establish a connection and continues displaying this message until a good connection has been established.

Figure 4 Unit Not Responding

To solve a connection problem, double check that the null modem cable is plugged into both serial ports and then *check that the PC's RS-232 settings match those of the Cs4000*.

To check the PC's RS-232 settings in Monitor3, select **Configure Serial Port** from the **File** menu. Monitor3 displays the Serial Communications Setup panel (Figure 5). Change the settings manually or click the **Detect** button to have Monitor3 automatically determine what the settings should be. Then click the **Apply Changes** button.

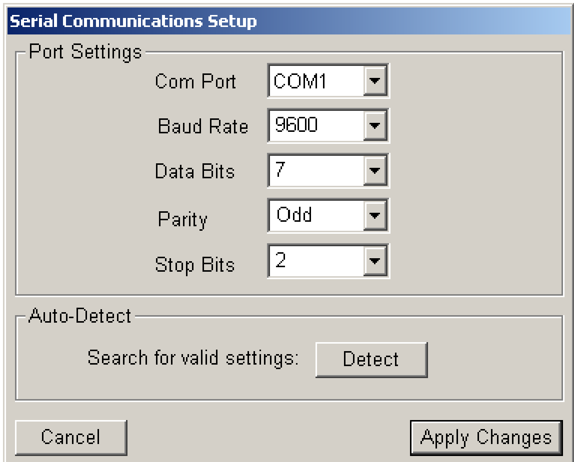

Figure 5 Serial Communication Setup

After the new settings have been applied, Monitor3 automatically attempts to reconnect to the Cs4000. If the connection is successful, Monitor3 displays new information in its title bar (top), status bar (lower left), and main window. See Figure 6.

The title bar displays the following information:

- The instrument type (here, Cs4000)
- The serial number (here, 6170)
- The PC's RS-232 interface (here, COM1)

The status bar displays the following information:

- The state of the instrument in the lower right (here, Operating).
- The countdown to the next update in the lower left (every 10 seconds).

Though not necessary once a good connection has been established, the user can change the *Cs4000's* RS-232 settings using Monitor3 or the optional LCD touchscreen. In Monitor3, use the **RS-232** item under the **System** menu. In the touchscreen, use the **RS-232** item under the **COMM** menu.

Chapter 4 - Operation

Prior to performing any of the operations described in this section, ensure that the installation procedures described in “Chapter 3 - Installation” have been performed and that communications have been established between the Cs4000 and the **Monitor3** application software.

In some installations, users may develop custom application software to provide remote control and monitoring capability. Please refer to **Appendix B – Programmer’s Guide** for details of command syntax and the complete command reference.

4.1 Monitor3 **Main Status Window**

Figure 6 shows the **Monitor3** main status window under normal operating conditions. The title bar of the main window indicates the cesium instrument model, serial number, and PC communications port. The status bar at the bottom of the main window indicates RS-232 communications activity on the left and instrument status (**Warming Up**, **Operating**, **Minor Fault**, or **Major Fault**) on the right.

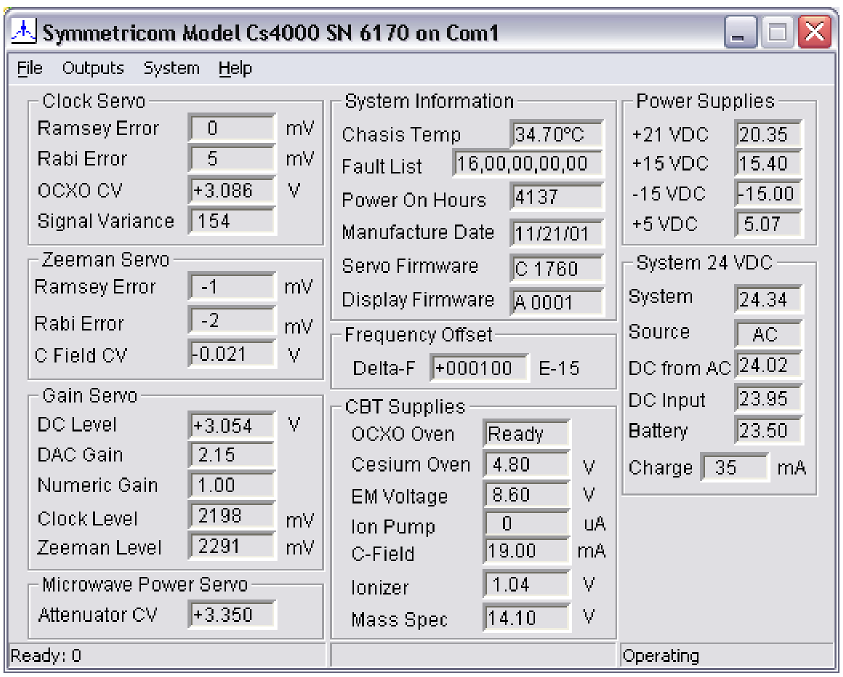

Figure 6 Monitor3 Main Status Window

The body of the main window displays operating and configuration data for the **Cs4000** instrument. The main window updates periodically (see **Unit Monitoring**, below). The left-hand column reflects parameters associated with the digital operating servos, including the main **Clock Servo**, the C-Field or **Zeeman servo**, the **Gain Servo**, and the **Microwave Power Servo**. The middle column contains the **System Information**, user programmed **Frequency Offset**, and monitors of the **Cesium Beam Tube Power Supplies**. The right hand column displays monitors of the internal **Power Supplies**.

Note that the "System 24 VDC" status is only indicated if the optional front panel is installed.

The definitions, interpretation, and normal values of the displayed data are discussed in the following sections as well as in Appendix A -Programmer's Guide**.**

4.2 Unit Monitoring and Logging Data

In order to adjust the polling rate and/or enable logging of data to disk, select **Configure Unit Monitoring** from the **File** menu.

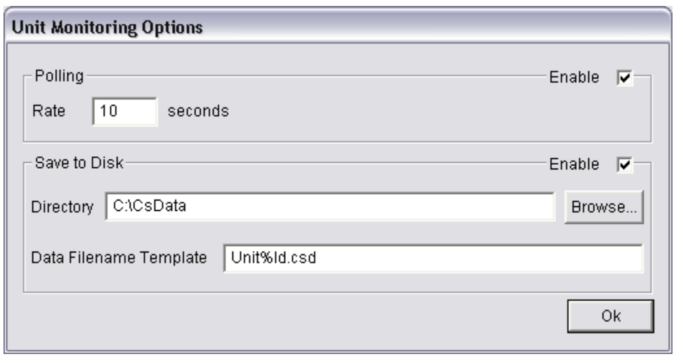

Figure 7 Unit Monitoring Options

From the **Unit Monitoring** panel, shown above, enable or disable monitoring with the **Enable Monitoring** checkbox and adjust the polling rate by typing a value into the **Polling Rate** edit box.

In order to save the monitor data to the PC's hard disk for archive or subsequent analysis, enable the **Create Data File** checkbox. The data will be saved at each polling interval in the **Output Directory** specified. The output directory can be changed either by typing a new directory name into the **Output Directory** field or by activating the **Browse…** panel and selecting a new directory from the tree displayed therein. Note that the data will not be saved if the specified directory does not exist.

The name for the data file may be entered into the **Data Filename Template** field. The macro field "**%ld**" is replaced with the serial number of the **Cs4000** instrument when the file is created. In our example, the saved data would appear in the file: **c:\Unit6170_Data.csv**.

The saved data file contains 44 comma-delimited columns. The first row of the file contains the column headings, which correspond with the data displayed by **Monitor3** as identified in Table 4, below. Note that the values displayed in the "**Typical**" column of Table 4 correspond to those in Figure 6, above.

Table 4 Interpretation of columns in the Data File created by Unit Monitoring

Col	Heading	Description	Typical	Range	Units
1	MJD	Fractional Days since 0hr November 17, 1858. Measured by PC clock	52991.8122		Days
2	ID	Serial Number of Unit	6170	0-99999	
3	UnitType	Model Identifier	400	400-410	
4	Factory	Data Taken at factory	0	0, 1	
5	State	Instrument state	00	00: Operating 01: Warm-up 10: Minor Alarm 11: Major Alarm	
6	Alarm1	First element of prevailing alarm list	00	00-FF	
7	Alarm2	Second element of prevailing alarm list	00	00-FF	
8	Alarm3	Third element of prevailing alarm list	00	00-FF	
9	Alarm4	Fourth element of prevailing alarm list	00	00-FF	
10	Alarm5	Fifth element of prevailing alarm list	00	00-FF	
11	StdDev	Signal Standard Deviation	125	100-200 (SP) 50-100 (EP)	mV
12	CRamErr	Clock Transition Ramsey Error	0	+/- 9999	mV
13	CRabErr	Clock Transition Rabi Error	2	+/- 9999	mV
14	CLevel	Clock Transition Signal Level	2181	0-9999	mV
15	VVCXO	VCXO Control Voltage	3666	0-5000	mV
16	ZRamErr	Zeeman Transition Ramsey Error	0	+/- 9999	mV
17	ZRabErr	Zeeman Transition Rabi Error	8	+/- 9999	mV
18	ZLevel	Zeeman Transition Signal Level	2262	0-9999	mV
19	VCField	C-Field Control Voltage	23	+/- 2500	mV
20	ICField	C-Field Current	19.0	17-21	mA
21	VuWave	Microwave Power Control	1809	0-5000	mV
22	DCLevel	DC Signal Level	2971	0-5000	mV
23	DACGain	Digital Preamplifier Gain	2.61	0-255	
24	NumGain	Numerical Gain	1.17	0.1-9999	
25	TChasis	Chassis Temperature	38.3	0-99	ºC
26	VcsOven	Cesium Oven Heater Voltage	6.5	0-15	V
27	OscState	OCXO Oven State	Ready	“Cold” or “Ready”	
28	VEM	Electron Multiplier Control Voltage	8.7	5-10	V
29	IIP	Ion Pump Current	0	0-10	μA
30	VMS	Mass Spectrometer Bias Voltage	16.6	12-18	V
31	VION	Ionizer Voltage Drop	1.0	0.5-1.5	V
32	OCXOTau	Clock OCXO Loop Time Constant	1.0	0.1-99.9	Sec
33	FreqTune	User Frequency Offset	+000000	+/- 999999	$x10^{-15}$
34	Pos24V	21 VDC Secondary Supply	21.71	0-99.99	V
35	Pos5V	5 VDC Secondary Supply	5.06	0-99.99	V
36	Pos15V	+15 VDC Secondary Supply	15.6	0-99.99	V
37	Neg15V	-15 VDC Secondary Supply	-15.5	-99.99-0	V
38	Version	Cesium module Firmware Version	D 1762		
39*	System24	System Main 24 VDC	24.34	0-99.99	V
40	ACDC24	24 VDC from AC input	24.02	0-99.99	V
41	DCIN24	24 VDC from DC input	23.95	0-99.99	V
42	Batt24	24 VDC from Battery	23.50	0-99.99	V
43	Charge	Charging Current	35	0-99.99	mA
44	Source	Source of System Main 24 VDC	AC	AC, DC, or BT	

*Please note that rows 39 through 44 (shaded) are only present when DCC option (LCD touchscreen, controller, Ethernet port) is installed.

4.3 Adjusting Output Frequency

The output frequency of the **Cs4000** may be adjusted by $\bar{y} = \pm 1 \times 10^{-9}$ with a resolution of 1 part in 10^{15}. This is generally used to optimize the accuracy of the Cs4000 and is accomplished by directly modifying the fundamental interrogation frequencies of the physics package and is thereby reflected on all outputs. In order to modify the programmed offset frequency, select **Delta-F…** from the **Outputs** menu.

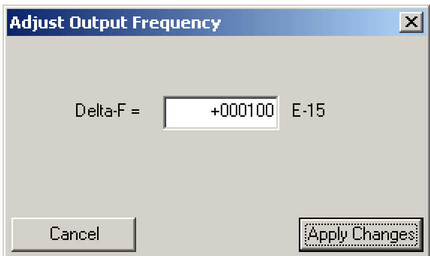

Figure 8 Adjust Output Frequency

The **Adjust Output Frequency** panel appears, as shown above, reflecting the current programmed offset of the **Cs4000**, in this case $\bar{y} = +1 \times 10^{-13}$. To change the offset frequency, enter a new value, between –999999 and +999999, into the edit field and click the **Apply Changes** button to upload the correction to the **Cs4000**. The updated output adjustment will be reflected in the **Frequency Offset** field following the next RS-232 update of the displayed data.

4.4 Slewing the Output Phase

In order to provide finer resolution adjustment of the output phase then is available from the **1 PPS Synchronization** feature, the output phase can be slewed, with 1 nS resolution, using the **Delta-T** function. This function is implemented by deliberately offsetting the output frequency of the **Cs4000** by either $\bar{y} = +1 \times 10^{-9}$ or $\bar{y} = -1 \times 10^{-9}$ for ***N*** seconds, thereby introducing a phase offset of plus or minus ***N*** nS, respectively. Note that, unlike the **1 PPS Synchronization** feature, the **Delta-T** function affects the phase on all outputs, including RF and 1 PPS. Note also that the output frequency of the instrument is significantly perturbed, by $\bar{y} = \pm 1 \times 10^{-9}$, for the duration of the adjustment. For example, phase advance of 1 mS, will introduce a $\bar{y} = +1 \times 10^{-9}$ error in all clock outputs, persisting for 10^6 seconds, almost 12 days! To avoid introducing an offset for such a long duration, first use the **Sync 1PPS** feature (Section 4.5, page 17) to bring the phase to within 100 ns of the desired value.

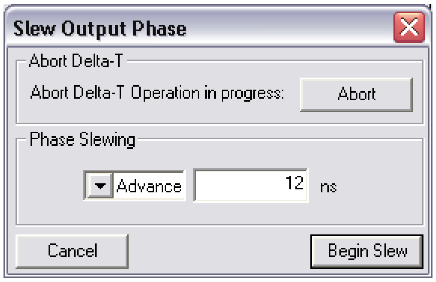

Figure 9 Slew Output Phase

In order to adjust the output phase, select **Delta-T…** from the **Outputs** menu. The **Slew Output Phase** panel appears. Enter the desired output phase and select either **Advance** or **Retard** from the pull down menu. Press **Begin Slew** to begin the phase slewing operation. The output frequency of the **Cs4000** will immediately be offset by either $\bar{y} = +1\times10^{-9}$ or $\bar{y} = -1\times10^{-9}$, depending on whether you've selected **Advance** or **Retard**, respectively. If you wish to abort the phase slewing operation in process, and return the instrument to its nominal frequency, return to the **Slew Output** Phase panel and press the **Abort** button at any time during the operation.

4.5 Synchronizing to a 1 PPS Source

The 1 PPS output of the **Cs4000** is generated by direct division of the 10 MHz RF output and, as such, reflects the phase of one particular cycle of the 10 MHz. In order to synchronize the 1 PPS output to an external user-supplied 1 PPS source, with 100 nS resolution, connect the 1 PPS source to the **1 PPS Sync** input (front or rear) and select **Synchronize 1PPS…** from the **Outputs** menu. The panel appears as shown below.

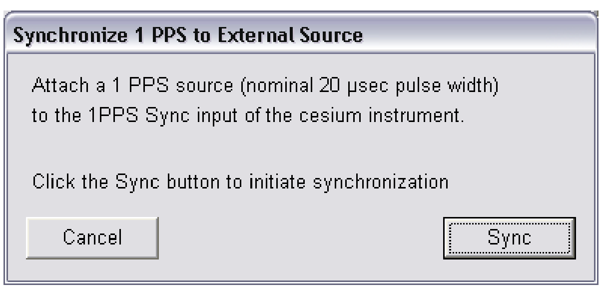

Figure 10 Synchronize 1 PPS to External Source

The **Cs4000** will synchronize its 1 PPS outputs to within +/- 100 nS of the applied external 1 PPS source if a rising edge is detected within 3 seconds after pressing the **Sync** button. Select **Cancel** to exit the panel without re-synchronizing the 1 PPS output.

4.6 Configure T1/E1 Telecommunications Outputs

This function is only enabled if the optional T1 and/or E1 cards are present in the Cs4000.

Please note that while a T1 and an E1 card can be installed together, two cards *of the same type* (e.g., T1 & T1) cannot.

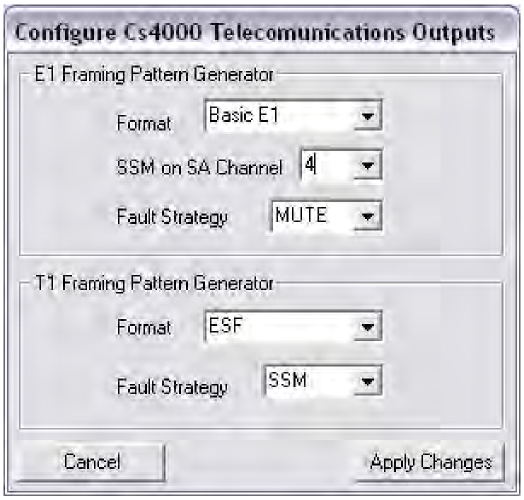

Figure 11 Configure Cs4000 Telecommunications Outputs

E1 Framing Pattern Generator

Select an E1 framing format:

- Basic E1
- CRC-4
- TS16 or CRC4
- TS-16

Select a fault strategy:

- Mute
- SSM

If the fault strategy is SSM, select one of the following channels for *SSM on SA Channel*: 4, 5, 6, 7, and 8.

Click the **Apply Changes** button to apply the new settings. Click the **Cancel** button to abandon the new settings and return to the main menu.

T1 Framing Pattern Generator

Select a T1 framing format:
- D4
- ESF

Select a T1 fault strategy:
- Mute
- SSM
- AIS

Click the **Apply Changes** button to apply the new settings. Click the **Cancel** button to abandon the new settings and return to the main menu.

4.7 Alarms

The **Cs4000** provides continuous monitoring of system power supplies, signal quality, and numerous physics package operating parameters, as indicated on the **Monitor3** main panel. Alarms are generated in the event that any of several parameters deviates from its acceptable value and are classified into two types:

- **Minor Alarm –** indicates out of nominal specification that should be noted but is not expected to impact instrument performance.
- **Major Alarm –** indicates detection of a fault that will cause the instrument to fail to meet specification.

In the event of **Minor Alarm**, the **ALARM** LED illuminates on the instrument front panel, in addition to the **POWER** and **LOCK** LEDs. All outputs remain active and the **ALARM** LED remains illuminated for as long as the alarm condition persists.

In the event of a **Major Alarm**, the **LOCK** LED turns off and the **ALARM** LED illuminates. All outputs are disabled. If the alarm condition ceases, the instrument restarts from its initial power-on condition. The current list of alarms is indicated by hexadecimal code in the alarm list on the **Monitor3** main panel. To see an annotated list of alarms, clear alarms, or set the priority of the restart alarm, select **Alarms…** from the **System** menu.

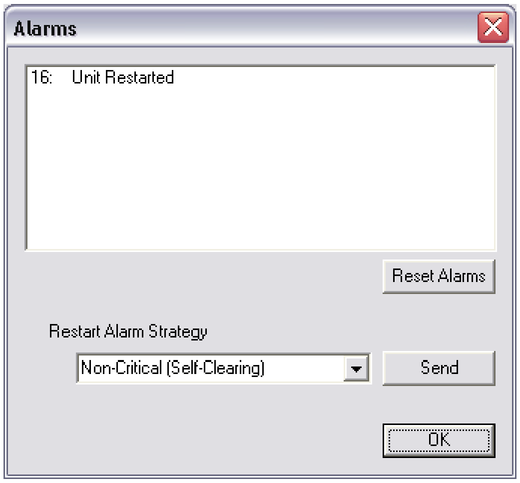

Figure 12 Alarms

The **Alarms** panel, shown above, enumerates all alarms currently present in the system. In order to clear standing alarms, press the **Reset Alarms** button. The list of pending alarms will be updated at the next regular polling interval. See the Table 7 on page 41 for a complete list of possible alarms.

There are two possible alarm strategies in the event of unit restart, which may be selected from the **Restart Alarm Strategy** pull-down menu and uploaded to the **Cs4000** by pressing the **Apply Changes** button. These are:

- **Non-Critical** (Default) - In the event of restart, the 0x16 alarm flag is set, outputs are muted during re-acquisition and restored upon successful lock. The 0x16 alarm flag remains set until cleared by the user.
- **Critical –** In the event of restart, the 0x16 flag is set, outputs are muted during re-acquisition and remain muted thereafter until the user clears the 0x16 alarm flag.

4.8 Event Logging

The **Cs4000** maintains a log of alarm indicators, including major and minor alarms as well as unit restart events. The Event Log is maintained in battery-backed non-volatile RAM in order to retain persistence through power cycles to enable forensic debugging in event of unit failure. Logged events include the activation of an alarm as well as the subsequent clearing of an alarm, whether automatically, due to the removal of the alarm condition, or due to user interaction.

To access the **Event Log**, select **Event Log** from **Monitor3**'s **View** menu.

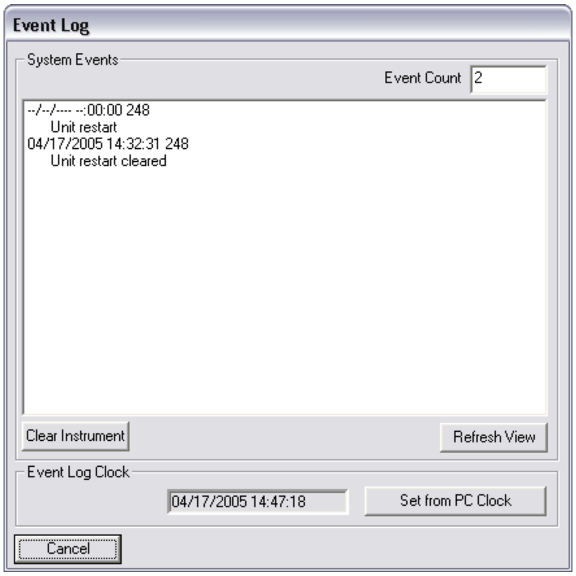

Figure 13 Event Log

The Event Log is downloaded from the Cs4000 when the **Event Log** panel is opened or when the user clicks the **Refresh View** button. Note that downloading the Event Log from the Cs4000 can take up to several minutes, depending on the number of events and the connection speed. Because of this necessary delay, the Event Log display panel is not automatically updated once initially displayed.

All events are identified by a time tag, indicating the time of the appearance or disappearance of the alarm condition. The time tag is composed of the date and time, as realized by the Cs4000 event log clock and the total number of operating hours on the instrument (248 in the example above). Because the Event Log clock is restarted upon power failure, the **Unit Restart** events necessarily occur at time **--/--/---- --:00:00**, as shown in the example above. Once the Event Log clock has been set, subsequent events are time tagged appropriately. To set the Event Log clock to the time on your PC, click **Set from PC Clock**. Note that if the front panel option is installed, the event log clock is set automatically by the TOD system and the “Set from PC Clock” option is not available on the Event Log panel.

The non-volatile Event Log storage contains a maximum of 128 events. Once the log is fully populated subsequent events are discarded. For this reason, it is useful to periodically check and clear the Event Log, particularly in installations where the power to the instrument is frequently cycled, thus producing numerous **Unit Restart** events. To clear the non-volatile Event Log in the Cs4000, press the **Clear Instrument** button. In permanent installations, Symmetricom recommends clearing the **Event Log** and setting the **Event Log Clock** upon installation.

4.9 Factory Settings

There are several settings available from the **Factory Settings…** panel on the **System** menu. Generally, these settings should not be modified, except by trained personnel, but are included in the **Monitor3** interface in order to accommodate particular applications.

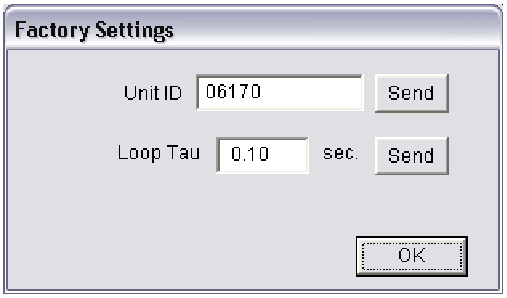

Figure 14 Factory Settings

The **Unit ID** is a 5-digit number, set in the factory to reflect the last 5 digits of the serial number of the instrument, as printed on the back panel label. To change the **Unit ID**, enter a new 5-digit value in the edit field and press the **Apply Changes** button.

The **Loop Tau** is the fundamental time constant of the OCXO servo. The factory default value of τ = 1.0 second is appropriate for most applications. Operation at other values of τ may compromise instrument performance. A complete discussion of the trade-offs inherent to selecting the **Loop Tau** is beyond the scope of this manual. This value should not be changed, except by knowledgeable personnel. To change the **Loop Tau**, enter a new value, between 0.1 and 99.9 seconds, in the edit field and press the **Apply Changes** button.

4.10 Communications

Upon delivery, the Cs4000 communicates with the following serial interface parameters:

- Baud = 9600
- Data bits = 7
- Parity = Odd
- Stop Bits = 2

In order to accommodate particular specialized installations, the RS-232 communications parameters of the Cs4000 instrument may be adjusted from the **RS-232…** panel on the **System** menu.

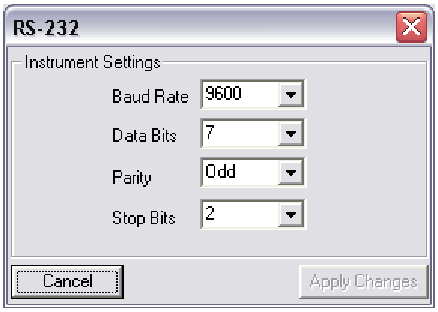

Figure 15 RS-232

To change the communications settings, select the desired settings from the pull-down menus and click on the **Apply Changes** button to upload the new settings to the **Cs4000**. After commanding the Cs4000 to alter its settings, **Monitor3** modifies its own communications parameters to the new Cs4000 settings and reestablishes communications with the new settings. Note that no settings are applied until the **Apply Changes** button is clicked**.** To exit the panel, retaining the previous settings, select **Cancel**.

4.11 Time-of-Day Clock

This feature is only available if the front panel option is installed. The **Cs4000** time of day clock is synchronized to the 1PPS output. To set or adjust the time of day, select **Time of Day…** from the **System** menu. The **Cs4000 Time-Of-Day Clock** panel appears as shown below.

Figure 16 Cs4000 Time-Of-Day Clock

To set the **Cs4000** time of day to the time on your PC, select either **Local Time** or **UTC** from the pull-down menu and click the **Send** button. To add or remove hours or seconds from the **Cs4000** time of day, click the **+** or **–** buttons as many times as necessary to perform the desired adjustment.

4.12 Ethernet

The LAN Ethernet port, which is part of the DCC/Touchscreen option, provides access to the Cs4000's Web Interface using a browser. If this option is not present, changes to the *Ethernet* window do not have an effect on the configuration of the Cesium instrument. For more information, see "Appendix D - Cs4000 Web Interface and LAN Network Port" on page 84.

Figure 17 Ethernet

To configure the LAN port's Ethernet settings, complete the following steps:

1. Select the **Ethernet** menu item from the **System** menu.
2. Select (check) **Enable Ethernet Port**.
3. Enter the appropriate values for **IP Address**, **Netmask**, and **Gateway**, or select the **Use DHCP** checkbox.
4. Click the **Apply Changes** button.

Chapter 5 - Maintenance & Troubleshooting

This section provides information about preventive maintenance, re-ordering parts, accessories, and re-shipment of product.

CAUTION…
- To avoid electrostatic discharge (ESD) damage to sensitive internal parts, observe proper ESD handling procedures.
- Never attempt to clean the interior of the instrument with a vacuum.

CAUTION…
To avoid damage, don't allow the interior of the instrument to come into contact with water under any circumstances.

NOTE…
- If you encounter problems during any of the following procedures, contact Technical Support (see page 57).
- Save the instrument's original packing materials for re-shipping the product. If these are not available, please contact Technical Support for a replacement.

5.1 Preventive Maintenance

The Cs4000 unit requires minimum preventive maintenance. Care should be taken to insure the unit is not exposed to hazards such as direct sunlight, open windows, or extreme heat. Should the unit require cleaning, the exterior chassis may be wiped off using a soft cloth dampened with mild soapy water.

Table 5 lists suggested preventive maintenance measures to be performed at periodically at the user's discretion, as time permits. These procedures are not required. Do not disassemble components solely for the purpose of inspection. During a component disconnection procedure, such as a cable removal or replacement, inspect components according to the inspection procedures.

Table 5 Maintenance

Item	Inspection	Corrective Action
Unit Case	Inspect for dirt or foreign material.	Clean the exterior of shelf with a soft dry cloth.
Cables	Inspect for pinched, worn, or damaged cable.	Replace at first opportunity.
Connectors	Inspect for loose or damaged connectors and jacks, bent or missing pins.	Tighten loose connectors. If damaged, replace at the first opportunity.
Power Fuse	Inspect for loose or damaged holder.	Contact Symmetricom Technical Support (see page 57)
Case Screws	Inspect for loose or missing screws or hardware on shelf.	If loose, tighten securely. Replace missing hardware.

5.2 Troubleshooting

If the alarm activates and the ALARM LED remains lit indicating a failure of the Cs4000, call Symmetricom Customer Assistance (see page 57) for instructions. Table 7 **on page 41** lists the two-digit hexadecimal fault codes along with their description. Prior to calling, please take note of the instrument model and serial numbers, any installed options, and the complete list of persistent alarm codes, available from the **Alarms…** panel on the **Monitor3 System** menu.

The complete list of possible alarm conditions is shown in Table 7 on page 41.

5.3 Shipping

To turn off the Symmetricom Cs4000 prior to shipment, remove the power. Remove all external connections and remove the unit from the rack or cabinet. Place the unit in its HAZMAT shipping container.

WARNING… When packing and/or shipping units that have the battery back-up option, remove the battery fuse from the F3 fuse holder (located on the rear panel) and tape it to the rear panel for transport.

5.3.1. Hazardous Material (HAZMAT) Shipping Considerations

Symmetricom cesium standards contain a small amount of cesium metal. The cesium isotope used (Cesium 133) is non-radioactive. However, because of its reactive chemical properties, the U.S. Department of Transportation (USDOT) and the International Air Transport Association (IATA) classify cesium as a hazardous material. During normal handling the Symmetricom Cs4000 presents no danger since the cesium is encased within a vacuum-sealed metal enclosure. Hazardous materials, depending upon their specific nature, are subject to certain shipping regulations of the USDOT and the IATA. These regulations govern the shipping case as well as its labeling.

The initial shipment of every Symmetricom cesium standard complies with HAZMAT regulations by using a shipping case that has been tested and certified. This case has been designed to prevent damage to the unit during shipment and to meet current hazardous-material shipping regulations. The case can be used repeatedly and should be retained for any future shipping requirements of the instrument. In addition, the following required labels have been placed on the case:

- FRAGILE
- DANGEROUS WHEN WET
- DANGER – NO PASSENGER AIRCRAFT
- CESIUM UN 1407

5.3.2. Shipping Products Back to the Factory

Return all units in the original packaging. After the standard packing procedure to protect the equipment, cesium products being returned for repair require special preparation for shipment as described in “Shipping Carriers” on page 27. Connectors should be protected with connector covers or the equipment should be wrapped in plastic before packaging. Take special care to protect the front and rear panels.

To return equipment to the factory or local representative for repair:

1) Call Symmetricom Customer Assistance to obtain a return material authorization (RMA) number before returning the product for service.
   - In the US, call 888-367-7966 or see page 57 for more choices.
   - Telephone menu short-cut: For RMAs, press “3” and then “2”.
2) Provide a description of the problem, product item number, serial number, and warranty expiration date.
3) Provide the return shipping information (customer field contact, address, telephone number, and so forth).
4) Pack all items into the original shipping container.
5) Ensure the container is properly marked as described in “Shipping Carriers” on page 40.
6) Ship the product to Symmetricom, transportation prepaid and insured, with the RMA number and serial numbers clearly marked on the outside of the container to:

Symmetricom, Inc. Attn: Service Dept.
34 Tozer Road
Beverly, Massachusetts 01915
USA
Tel: +1 978 927 8220
Fax: +1 978 927 4099

5.3.3. Shipping Carriers

The shipper is responsible for the overall condition of the Hazardous Material shipping case; such as latches locked (if applicable), no visible damage to case and the proper placement of all labels on the case. Figure 18 illustrates the proper placement of labels. Make sure an address label, proper HAZMAT labels, and packing slip (if necessary) are affixed to the shipping case and are clearly visible.

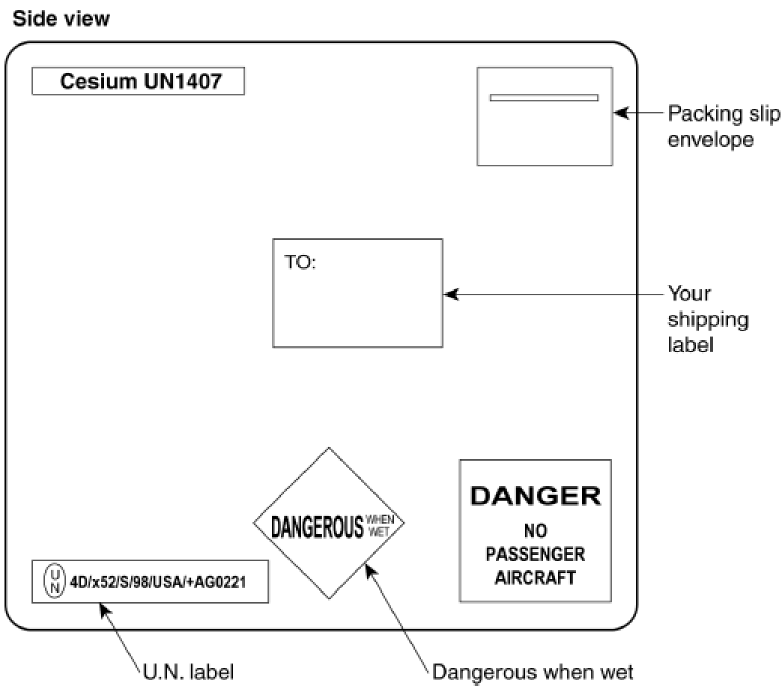

Figure 18 Typical Hazmat Label Placement

Several United States and international shipping companies, such as Federal Express and Intercontinental Transportation Services (617-569-4400), can accommodate properly packaged hazardous materials. Contact one of these shipping companies for assistance. If you need additional help, call Symmetricom Customer Assistance (see page 57).

Freight carriers typically request the following information:

- Proper Shipping Name: Caesium (Cesium) Dangerous When Wet
- Class Or Division: 4.3 UN or ID No.: UN1407
- Type Of Packing: One Fiberboard Box x5 Grams
- Packing Instructions: 412

5.4 Re-Ordering Information

Contact the sales office to re-order any subassembly or accessory or to obtain a current list of subassemblies, accessories, and part numbers (see Section 2.6 on page 7). When you know what items you are ordering, supply the subassembly or accessory name and its part number along with the purchase order number to our sales office.

5.5 Storage

During storage of the Cs4000, there are two factors to consider: Cesium beam tube vacuum and shelf life.

CAUTION…
Failure to observe the following storage guidelines may reduce the lifespan and performance of the Cesium Beam Tube.

5.5.1. Cesium Beam Tube Vacuum

If the Cs4000 is stored for extended periods of time (>6 months), the unit should be powered on for a minimum of 30 minutes every six months in order to maintain the tube vacuum. The Cs4000 must be turned-on and operated for a minimum of 30 minutes on or before the first six-month storage interval.

5.5.2. Cesium Beam Tube Shelf Life

Extended high temperature storage (>50°C) reduces the expected operating life of the Cesium Beam Tube. The reduction in tube life expectancy is approximately 4 months for each year of storage at 70°C.

Chapter 6 - Theory of Operation

This section provides the theory of operation of the Cs4000 Cesium Frequency Standard. It is intended to supplement the functional description provided in earlier chapters and provide a more complete understanding of instrument operation.

6.1 Cesium Frequency Standard Concept

As described in "Chapter 1 - Introduction**"**, the SI unit of time is defined as follows:

"The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom."

Figure 19, below, shows a conceptual diagram of the **Cs4000**.

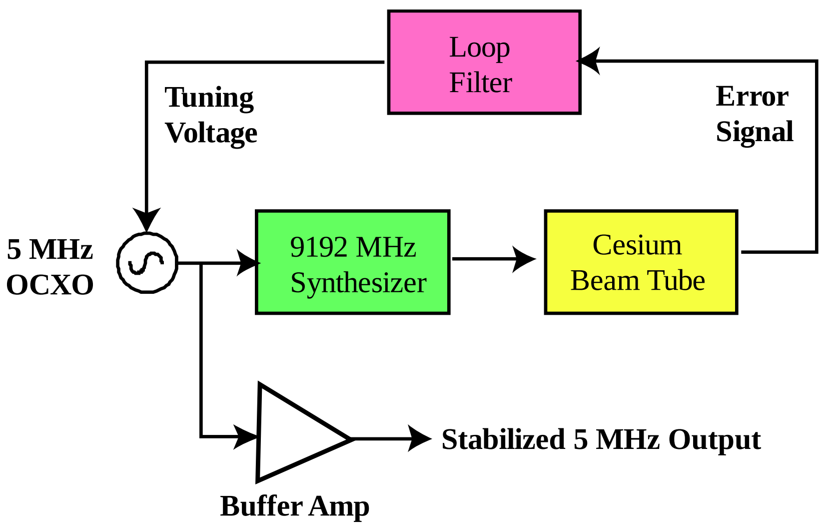

Figure 19 Conceptual Diagram of the Cs4000

The fundamental accuracy and stability of the **Cs4000** are derived from its "physics package" or "Cesium Beam Tube," whose function is to provide a near-ideal environment for continuously measuring the cesium hyperfine transition. All outputs of the **Cs4000** are derived from an ovenized low phase noise 5 MHz quartz oscillator, whose output frequency is converted up to 9,192,631,770 Hz and applied to the Cesium Beam Tube (CBT). The CBT produces an error signal, whose sign and amplitude reflect the detuning of the quartz oscillator with respect to the definition of time. In normal operation, the synthesizer, under microprocessor control, provides optimal interrogation of the cesium resonance, periodically hopping between interrogation points located on either side of the principal cesium resonance. The microprocessor-based "Loop Filter" or "Servo" continuously demodulates and integrates the error signal and adjusts the oscillator tuning voltage of the oscillator so as to null the integrated error signal, thereby guaranteeing the long-term stability and accuracy of the 5 MHz output frequency. For measurement intervals that are short compared to the time constant of the loop filter, which is typically on the order of $\tau = 1$ second, the output signal characteristics, phase noise and stability, are determined by the properties of the quartz oscillator. At longer times, the output signals reflect the properties of the CBT.

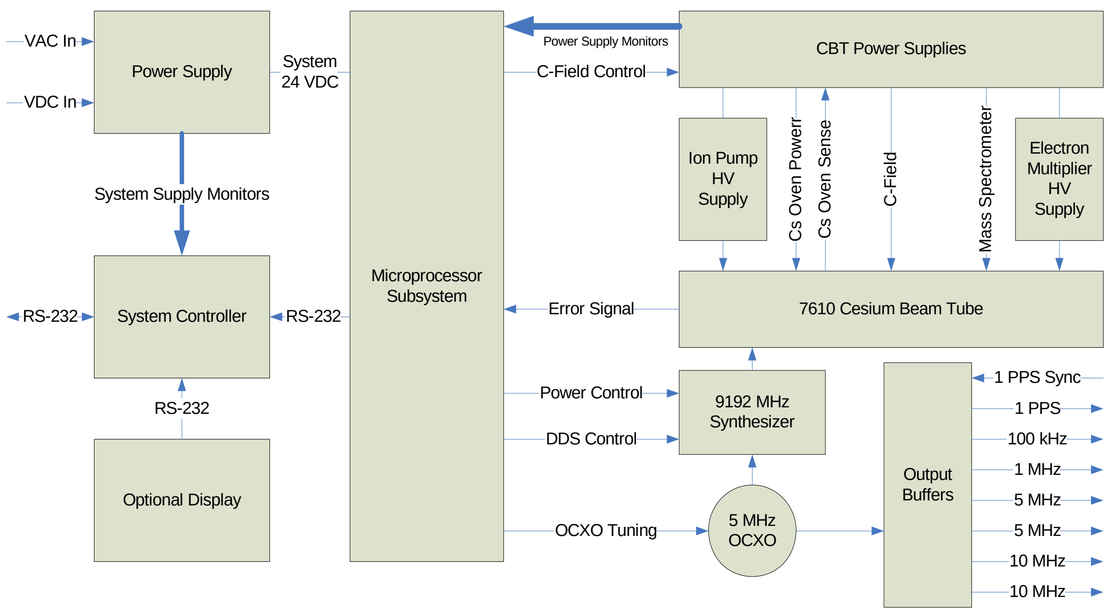

Figure 20 Block Diagram of the Cs4000

The principal components of the Cs4000 include:

- A 5 MHz ovenized quartz oscillator that provides the reference for all outputs.
- An RF synthesizer that converts the 5 MHz reference up to the cesium hyperfine frequency, tunable around 9192631770 Hz.
- The Cesium Beam Tube (CBT), which produces an error signal proportional to the detuning of the RF from the cesium hyperfine resonance frequency.
- The microprocessor subsystem, which modulates the RF interrogation and steers the quartz oscillator, implements additional servos for magnetic bias (“C-“) field, microwave power, and signal gain, and monitors and reports system health parameters.
- RF and 1 PPS Output buffers
- The System Controller, which handles communication between the external RS232 interface (Monitor3), the optional touchscreen display, and the main microprocessor.
- The main power supply and other secondary power supplies.

6.2 Cesium Beam Tube

The heart of the instrument is the Symmetricom Model 7610 Cesium Beam Tube (CBT). The 7610 is a third-generation CBT, reflecting 30 years of continuous manufacture and improvement. The CBT is illustrated schematically in Figure 21 below.

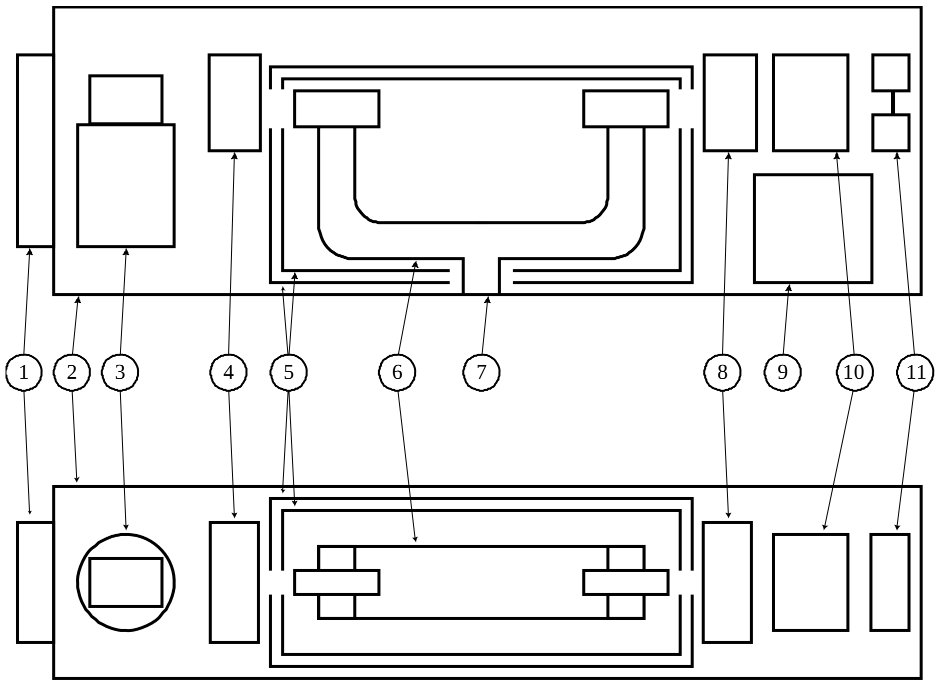

Figure 21 Schematic of the Model 7610 Cesium Beam Tube

Key to Figure 21:

(1) Vacuum Ion Pump
(2) Vacuum Jacket
(3) Cesium Oven
(4) "A" Magnet Assembly
(5) Magnetic Shield (2X)
(6) RF Resonator
(7) RF Input Window
(8) "B" Magnet Assembly
(9) Electron Multiplier
(10) Mass Spectrometer
(11) Hot-Wire Ionizer

The key components of the CBT are contained within a welded stainless vacuum vessel (**2**), wherein an ion pump (**1**) maintains a high vacuum that minimizes signal attenuation due to collisions between cesium atoms in the beam and background gas. The cesium oven (**3**) contains a volume of cesium adequate to provide the necessary cesium beam flux for the lifetime of the CBT. The oven is monitored by a thermistor and maintained at constant temperature by the CBT power supply. A collimator assembly at the output aperture of the oven forms a beam directed down the axis of the CBT. An inhomogeneous magnetic field, generated by the "A"-magnet state selector (**4**) separates the beam into two components, each of which is principally composed of atoms in one of the two hyperfine states, F=3 or F=4. One of these components is directed down the axis of the beam tube while the other is discarded. The beam, composed principally of atoms in the one hyperfine state passes through a double-walled magnetic shield (**5**) into the resonance interrogation region, within which a small magnetic bias field (the “C-field”) serves to separate the magnetic sub-states of the hyperfine level while maintaining its quantization axis. Within the interrogation region, the atoms pass through the U-shaped resonance cavity (**6,** the “Ramsey” cavity), which induces a spin-flip resonance response with the characteristic Ramsey pattern (see resonance examples below). Following the resonance interaction, the atoms exit the shielded interrogation region and pass through the second state selector magnet assembly (**8**, the “B”-magnet), which directs atoms which have undergone the transition to the heretofore unpopulated state into the detector assembly, while rejecting those remaining in the originally selected state. The detector assembly is composed of the hot wire ionizer (**10**), which effectively strips an electron from the impinging cesium atoms, creating Cs+ ions, the mass spectrometer (**9**), which isolates the cesium ions from other atomic species, and the electron multiplier (**11**), which provides amplification of the signal.

The output signal, a current of typically several tens of nanoamperes, is converted to a voltage by a low-noise transimpedance amplifier. The voltage signal is amplified by a digitally controlled variable gain amplifier and then applied to the input of a boxcar integrator whose output is latched and read by a 16-bit analog-to-digital converter (ADC). A single interrogation of the CBT is accomplished by setting the 9 GHz synthesizer to the measurement frequency, enabling the boxcar integrator, waiting for the designated dwell time, and reading the result from the ADC. In the **Cs4000**, interrogations are performed at a rate of 38 Hz and with a dwell time of 23 ms.

The cesium atom possesses a nuclear spin of I=7/2. In its unperturbed ground state, the nuclear spin couples with the S=1/2 spin of its single valence electron to form two distinct ground states identified by the quantum number $F=I\pm S$, i.e. F=3 or F=4. Each of these ground states is composed of (2F+1) degenerate Zeeman sub-levels, identified by their projection along an applied magnetic field by the magnetic quantum number m_F, where m_F takes on the integer values from $-F$ to $+F$. The behavior of the cesium ground state sublevels in an applied magnetic field is shown below in Figure 22.

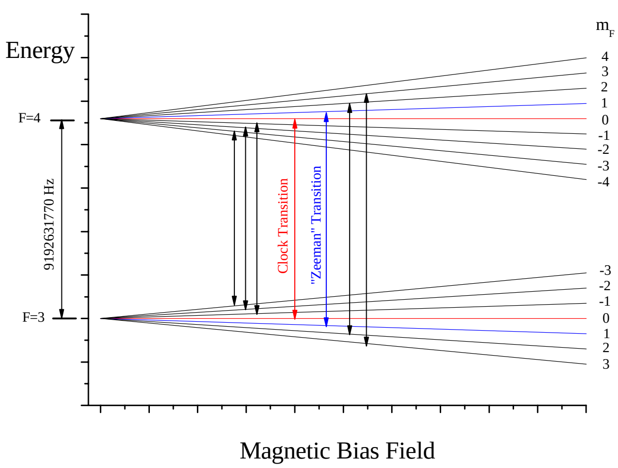

Figure 22 Behavior of the cesium ground state sublevels in a magnetic field

With the exception of the m_F=0 sublevels, all of the energy sublevels exhibit a linear dependence on the applied magnetic field of approximately 350 kHz/Gauss. For this reason, the Cesium Frequency Standard operates on the F=3, m_F=0→ F=4, m_F=0, “Clock Transition,” whose frequency is, to first order, independent of perturbing magnetic fields. Within the Cesium Beam Tube, the microwave interrogation is precisely aligned so as to only drive transitions between like sublevels, i.e. Δm_F=0. There are, thus, seven possible transitions between the F=3 and F=4 ground states, as shown in **Figure 22**, above. In order to avoid interference of the six field-dependent transitions on the measurement of the clock transition, it is necessary to apply a small bias field, the so-called “C-Field” to the resonance interrogation region. This deliberately shifts the resonance frequency of the field dependent transitions away from the clock transition frequency.

The complete spectrum of the 7610 CBT, showing all seven allowed Δm_F=0 transitions is shown below in **Figure 23** as the RF frequency is swept across 400 kHz around 9192631770 Hz.

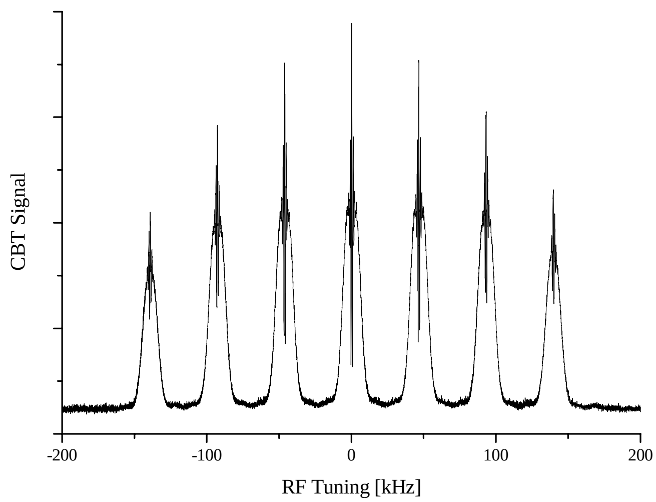

Figure 23 The complete spectrum of the 7610 CBT

The complete 7610 CBT spectrum includes all 7 allowed Δm=0 magnetic dipole transitions between the Zeeman sublevels of the two ground hyperfine states of cesium. With the exception of the central, or “Clock” transition, the frequencies of these transitions all exhibit a linear dependence on external magnetic field. The separation between the transitions is provided by the applied C-field and the frequency splitting is termed the “Zeeman frequency,” here 46.4 kHz. The clock transition, which is chosen for its relative insensitivity to applied field, exhibits only a small second-order Zeeman shift. The clock transition is shown in greater detail below.

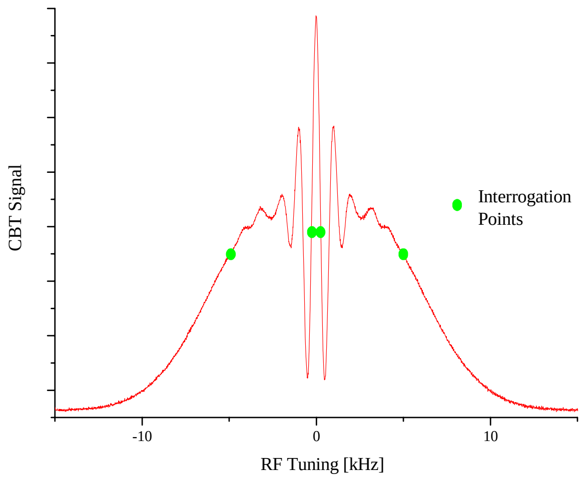

Figure 24 Zeeman Frequency, Clock Transition

The clock transition exhibits the characteristic Ramsey separated oscillatory fields pattern, generated by passing through two spatially separated regions of microwave field at the two ends of the U-shaped resonance cavity. The relatively narrow “Ramsey fringe” exhibits a line width of 500 Hz, dictated by the Fourier transform of the flight time between the two regions. The fringe sits atop the broader “Rabi Pedestal,” whose 10 kHz linewidth reflects the travel time through one of the two regions.

6.3 Clock Servo

The purpose of the clock servo is to steer the control voltage of the ovenized quartz oscillator (OCXO) so that it’s output frequency (multiplied up to 9192631770 Hz) is aligned with the center of the clock resonance transition, ν_C. A measurement is composed of a pair of interrogations of the CBT response at two points located symmetrically about the clock frequency at the steepest points of the Ramsey fringe, at $\nu = \nu_C \pm 250\text{Hz}$. The **Ramsey Error** signal is the voltage difference (reported in millivolts) between the “left” and “right” interrogations of the Ramsey fringe. The **Ramsey Error** signal is integrated numerically by the microprocessor, using a gain factor determined by the desired loop time constant (factory set to τ=1 second), and applied to the 24-bit digital-to-analog converter (DAC) which controls the tuning voltage of the OCXO so as to drive the **Ramsey Error** to zero. For monitoring purposes, an exponential average of the **Ramsey Error**, with a 1 second time constant, is maintained by the microprocessor and reported by **Monitor3**. In normal operation, the reported **Ramsey Error** is driven to zero, though occasionally small fluctuations of 1-2 mV may be observed.

As an integrity test, the microprocessor periodically performs a measurement of the **Clock Servo Rabi Error** by performing a pair of interrogations at $\nu = \nu_C \pm 5000\text{Hz}$. The **Clock Servo Rabi Error** is continuously averaged by the microprocessor with a 100 second time constant. Insofar as the Ramsey fringe is symmetrically positioned atop the Rabi pedestal, this value reads zero. In the unlikely event that the clock servo has locked to the wrong peak of the Ramsey fringe, producing a clock output error of nearly $\bar{y} = 10^{-7}$, the **Clock Servo Rabi Error** would exceed its error threshold of 50 mV, a major alarm (0x02) would be declared, and the unit would perform a restart. In normal operation, the reported value of the **Clock Servo Rabi Error** lies well within +/- 25 mV.

The full tuning range of the OCXO is $5\text{x}10^{-7}$ for an **OCXO Control Voltage** range of 0-5 VDC, which is adequate, in the presence of oscillator aging, to guarantee stable acquisition and lock for the lifetime of the **Cs4000** instrument. Typically, upon delivery, the **OCXO Control Voltage** is between 2 and 4 VDC. A minor alarm (0x08) is declared if the **OCXO Control Voltage** falls below 0.5 VDC or rises above 4.5 VDC.

For integration times short compared to the servo loop time constant, the OCXO is essentially free running and thus, provides a reference against which the noise properties of the CBT signal can be measured. The **Signal Deviation** parameter reports the RMS deviation of the measured **Ramsey Error**. This parameter can be taken as a rough indication of the Allan Deviation of the CBT signal. On this time scale, the CBT signal exhibits white Gaussian noise statistics, which lead to $\sigma_y(\tau) \propto \tau^{-1/2}$ and thus, properly scaled, the **Signal Deviation** parameter is proportional to the 1-second Allan deviation of the **Cs4000** instrument. The absolute value of the **Signal Deviation**, and thus the scale factor necessary to predict Allan deviation, varies slightly from instrument to instrument. Nonetheless, monitoring this parameter provides a valuable independent indicator of the state-of-health of the instrument. Typically, a standard performance **Cs4000** exhibits **Signal Deviation** between 120 and 150. An Enhanced Performance instrument exhibits **Signal Deviation** between 70 and 90.

The relative deviation of the CBT measurements is continuously monitored by the **Cs4000** adaptive clock servo algorithm as a measure of **Signal Quality**. If the **Cs4000** detects a transient disturbance, which might occur, for example, if the instrument is mechanically disturbed while operating, a minor alarm (0x07) is declared. In this case, the instrument performance is not degraded and the alarm automatically clears when the transient subsides. If the disturbance persists, and instrument performance may be compromised, the minor alarm (0x07) is promoted to a major alarm (0x07).

6.4 Zeeman Servo

As discussed earlier, it is necessary to apply a magnetic bias field (the “C-Field”) to the RF interrogation region in order to prevent the other six transitions in the RF spectrum from interfering with the clock transition. To first order, the magnitude of this field has no (linear) effect on the frequency of the clock transition. There is, however, a second-order shift of the clock transition given by:

$$\nu_C = \nu_0 + \frac{8}{\nu_0} * \delta\nu_Z^2$$

Where ν_0 is the unperturbed clock frequency (ν_0=9192631770 Hz, by definition), and $\delta\nu_Z$ is the Zeeman frequency, defined to be the splitting between adjacent hyperfine transitions and which varies linearly with the applied C-field. In the **Cs4000**, the Zeeman frequency, $\delta\nu_Z$=46,379.831 Hz, leading to a corrected clock frequency of ν_C=9192631771.8720 Hz. Thus, the second-order Zeeman correction to the clock frequency is 1.872 Hz, about 2 parts in 10^{10}. The C-field must be held stable to better than 30 ppm in order to guarantee long-term stability of the **Cs4000** at the level of 1 part in 10^{14}.

In order to stabilize the C-Field for long-term operation and in the presence of possibly changing external fields, the C-Field current is servoed to the atomic spectrum itself. Periodically, a measurement is made of the Ramsey fringe of the first Zeeman transition to the right of the clock transition, i.e. at $\nu = \nu_C + \delta\nu_Z \pm 250\text{Hz}$. The measurement result is exponentially filtered and used to adjust the **C-Field Control Voltage**, which gently steers the **C-Field Current**, so as to drive the **Zeeman Ramsey Error** to zero. **Monitor3** reports the **Zeeman Ramsey Error**, which averages to zero in normal operation but may vary by +/- 10 mV depending on the presence of time-varying external fields. **Monitor3** also reports the **Zeeman Rabi Error**, which is measured at $\nu = \nu_C + \delta\nu_Z \pm 5000\text{Hz}$. Because of the high sensitivity of the Zeeman transition to magnetic field, it is not unusual for the **Zeeman Rabi Error** to be as high as +/- 75 mV, particularly in the presence of external magnetic fields near the instrument. If the **Zeeman Rabi Error** exceeds 160 mV, it may indicate that the servo is locked to the wrong Ramsey fringe, leading to a clock offset of 5 parts in 10^{12}. In this case, a major alarm (0x02) will be declared and the **Cs4000** will attempt to reacquire the Zeeman servo. **Monitor3** also reports the **C-Field Control Voltage**, which has a range of +/- 2.5 VDC and is set to 0 VDC prior to shipment, as well as the **C-Field Current**, which is measured in mA and reported in the **CBT Supplies** section of the **Monitor3** main panel. Typically, the **C-Field Current** lies between 18.5 and 19.5 mA. If the **C-Field Current** falls below 16 mA or rises above 22 mA, a major alarm (0x05) will be declared.

6.5 Gain Servo

As the CBT ages, the signal level decreases and the level of background signal detected rises. The purpose of the gain servo is to twofold: (a) to guarantee that the resolution of the ADC is fully utilized and (b) to present consistent signal levels to the clock servo, as well as the other measurements and servos. The gain servo is composed of two elements: the digitally controlled hardware gain (**DAC GAIN**) and the software-implemented **Numerical Gain**.

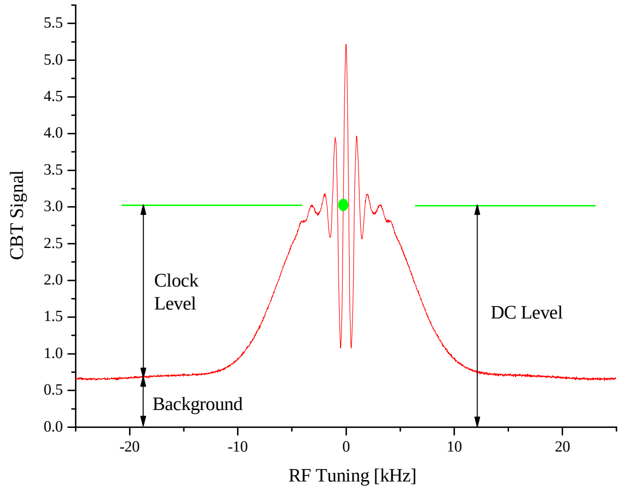

Figure 25 CBT Signal & RF Tuning

The function of the **DAC Gain** is to amplify the **DC Level**, measured at the clock Ramsey interrogation points, to approximately 3 volts, in order to make optimal use of the resolution of the 16 analog-to-digital converter which reads the CBT signal. The **DAC Gain** varies from 1.4 to 256 over the life of the instrument as 256/N, where N is an integer that varies from 180 to 0. This relatively coarse adjustment is performed only when the **DC Level** falls below 2.0 V or rises above 4.0 V. A minor alarm (0x18) is declared when the **DAC Gain** reaches 256, which indicates that the CBT is nearing the end of its useful life.

The function of the **Numerical Gain** is to present a consistent discriminator slope to the control servos, independent of the signal or background levels or **DAC Gain** adjustment. The **Numerical Gain** is a floating-point number, typically of order 1, which varies continuously throughout instrument life so as to guarantee that the **Clock Level** is 2200 mV. If the **Clock Level** falls below 1320 mV or rises above 3080 mV a major alarm (0x01) is declared.

In normal operation, the **Cs4000** periodically measures the background, mid-way between the clock transition and the Zeeman transition. The numerical gain is adjusted continuously and the **DAC Gain** is discretely adjusted if necessary.

6.6 Microwave Power Servo

The short-term stability, accuracy, and environmental sensitivity of the **Cs4000** are all optimized when the microwave power in the RF resonator is optimized to provide maximum signal level at the clock Ramsey interrogation points.

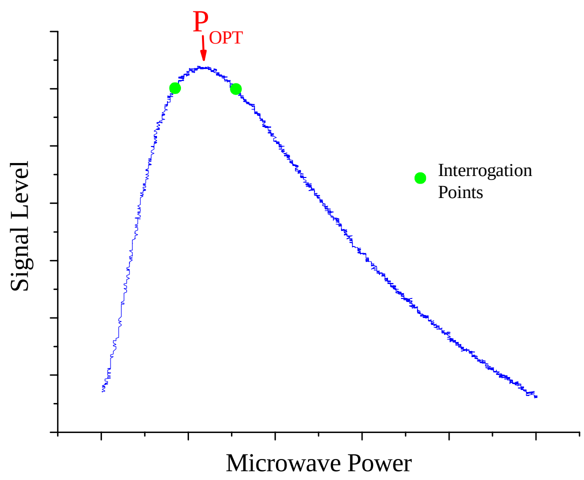

Figure 26 Maximum Signal Level at the Ramsey Interrogation Points

Figure 26 above, shows the microwave power dependence of the 7610 CBT signal, measured at the clock Ramsey interrogation point as the output. The optimum microwave power point, designated P_{OPT} is indicated in the figure. In order to ensure that the microwave power is always optimized, the **Cs4000** periodically measures the signal response to small variations of the microwave power, as shown in the figure, alternately performing the measurement on the left- and right-side clock Ramsey interrogation points. This response is input to a digital servo, whose output, the **Microwave Power Control Voltage,** controls a variable attenuator in the microwave synthesizer, higher voltages producing lower output power at 9192 MHz. The range of the **Microwave Power Control Voltage** is 0-5 V and the synthesizer is set in the factory such that P_{OPT} is accomplished near to a setting of 2.5 V. In normal operation the **Microwave Power Control Voltage** may vary from 0.5 to 4.5 volts, particularly in response to changes in ambient temperature.

6.7 Unit Initialization

Upon power-up, the **Cs4000** performs the following sequence of operations:

Table 6 Warm-up Sequence

	Warm-up Sequence	Completion Indicator
i	Firmware and non-volatile RAM consistency check	RS-232 communication begins
ii	OCXO Oven Warm-up	OCXO Oven changes from “cold” to “Ready”
iii	Cesium Oven Warm-up	Cesium Oven voltage drops below 10 V
iv	Clock Rabi Acquisition	Clock Rabi Error < 40 mV
v	Clock Ramsey Acquisition	Clock Ramsey Error < 40 mV
vi	Gain Servo Initialization	Clock Level > 2000 mV
vii	Zeeman Rabi Acquisition	Zeeman Rabi Error < 40 mV Front panel Lock LED illuminates

Upon completion of the warm-up sequence, the offset frequency of the instrument is expected to meet its specified accuracy, though it may continue to move by several parts in 10^{13} over the first several hours of operation as the instrument temperature equilibrates and the Zeeman, gain, and microwave power servos converge on their optimum values.

6.8 Alarms and Indicators

In addition to the system monitors relating to servos and Cesium Beam Tube parameters, discussed in earlier sections of the this chapter, periodic measurements are made of primary and secondary system voltages and CBT power supplies. These are generally self-explanatory from the front panel of **Monitor3**. The complete list of possible alarm conditions is shown in Table 7, on the following page.

Table 7 Alarm Descriptions, Conditions, and Level

Alarm	Description	Error Condition	Level
0x01	Clock Fringe Level	< 1320 mV or >3080 mV	MAJOR
0x02	Clock Rabi Asymmetry	> 50 mV	MAJOR
0x03	Zeeman Rabi Asymmetry	> 160 mV	MAJOR
0x04	Mass Spec Voltage	+/-5% of factory setting	MAJOR
0x05	Cfield Current	< 16 mA or > 22 mA	MAJOR
0x06	EM Voltage	Control <7 V or >13V	MAJOR
0x07	CBT Signal Quality	Signal Quality degraded	MINOR: Signal Noisy MAJOR: Signal Failure
0x08	VCXO Tuning voltage	< 0.5 V or > 4.5 V	MINOR
0x09	Ambient Temp	> 80°C	MAJOR
0x12	5V Supply	< 4.75V or > 5.25 V	MAJOR
0x13	Positive 15 V Supply	< 13.75 V or > 17.0 V	MAJOR
0x14	Negative 15 V Supply	> -13.75 V or < -17.0 V	MAJOR
0x16	Unit Restart	Set on Reboot	MAJOR/MINOR (see Section 4.6)
0x17	Module Configuration	Consistency check on Reboot	Informative only
0x18	DAC Gain at Maximum	= 256	MINOR
0xF1	Cesium Oven Voltage	> 10.0 V (after Cs lock)	MAJOR
0xF2	Oscillator Oven Warm-up	Unlock (after Cs lock)	MAJOR
0xF3	Ionizer Voltage Out of Range	>160 mV off factory setting	MAJOR
0xF4	Ion Pump Current	> 175 µA	MAJOR
0xF5	21 V Power Supply	< 17 V or > 24 V	MAJOR

Chapter 7 - Specifications

7.1 Electrical Specifications

Frequency Outputs

One each 100KHz & 1 MHz Sine

Amplitude:	1 VRMS
Harmonic:	< -40 dBc
Non-harmonic:	< -80 dBc
Connector:	BNC
Load impedance:	50 Ohms
Location:	Rear Panel

2 each 5MHz & 10MHz Sine

Amplitude:	1 VRMS
Harmonic:	< -40 dBc
Non-harmonic:	< -80 dBc
Connector:	Type N
Load impedance:	50 Ohms
Location:	Rear Panel

Timing Outputs

Format:	(3) 1 PPS
Amplitude:	>3.0V into 50 Ohms
Pulse width:	20 μs positive pulse
Rise time:	<5 nS
Jitter:	<1 nS RMS
Connector:	BNC
Load impedance:	50 Ohms
Location:	Rear Panel (2), Front Panel (1)

Timing Inputs

Sync input:	(2) 1 PPS
Connector:	BNC
Load impedance:	50 Ohms
Location:	Rear Panel (1), Front Panel (1)

RS-232 System Interface and Control

RS-232-C (DTE Configuration) Complete remote control and interrogation of all instrument functions and parameters. Two 9-pin male rectangular D subminiature type, one on the rear panel and one on the front panel. (Front panel RS-232 omitted on units equipped with optional LCD Touchscreen)

Alarm (TTL):	BNC (Rear Panel)
Output TTL:	TTL High, normal
	TTL Low, fault

Circuit is TTL open collector with internal pull-up resistor.

Circuit can sync up to 10mA

7.2 Performance Specifications

Performance

	Standard Perf.	**High Perf.**
Accuracy:	+/-1.0E-12	+/-5.0E-13
Warm-up time:(typical)	30 Min.	30 Min.
Reproducibility:	+/-2.0E-13	+/-2.0E-13
Settability Range:	+/-1E-9	+/-1E-9
Settability Resolution:	1E-15	1E-15

Stability

Avg Time (s)	**Standard Perf. Allan Deviation**	**High Perf. Allan Deviation**
1	<1.2E-11	<5.0E-12
10	<8.5E-12	<2.7E-12
100	<2.7E-12	<8.5E-13
1,000	<8.5E-13	<2.7E-13
10,000	<2.7E-13	<8.5E-14
100,000	<8.5E-14	<2.7E-14
Floor	<5.0E-14	<1.0E-14

SSB Phase noise

Offset (Hz)	Standard Perf. 5 MHz Output	High Perf. 5 MHz Output
1	<-95 dBc	<-102 dBc
10	<-130 dBc	<-130 dBc
100	<-145 dBc	<-145 dBc
1,000	<-155 dBc	<-155 dBc
10,000	<-155 dBc	<-155 dBc
100,000	<-160 dBc	<-160 dBc

7.3 Environmental & Physical Specifications

General Environment

Operating

Temperature:	0° C to 50° C
Humidity:	95% up to 50° C, Non-Condensing

Non-operating (transport)

Temperature (storage):	-40° C to 70° C
Temperature (short term):	-40° C to 75° C
Magnetic field:	0 to 2 gauss
Altitude (operating):	0 to 15,000 feet

AC Power Requirements

Voltage:	85 to 264 VAC
Frequency:	47 to 63 Hz
Power (Operating):	65W
Power (Warm Up):	90W
AC Fuse (F1):	Fuse, Slow, 2.0A, 250V, M5x20 (part # 45-00030-02R0)

DC Power requirements

Input Voltage:	36 - 75 VDC
24 VDC Option:	18 - 36 VDC
Power (Operating):	60W
Power (Warm up):	70W
DC Fuse (F2):	Fuse, Slow, 4.0A, 250V, M5x20 (part # 45-00030-04R0)
DC Mating Connector:	Cannon type MS3106E14S-5S

Dimensions and Weight

17.22” W x 5.22” H x 20.63” D

Weight: 45lbs (20.4 kg)

7.4 Options

Internal Standby Battery Option

Capacity	45 minutes @ 25° C from full charge without optional LCD touchscreen
	20 minutes @ 25° C from full charge with optional LCD touchscreen
Charge time:	16 hours max. (Fully discharged)
Charge source:	AC or DC power
Battery Fuse (F3):	Fuse, Slow, 6.0A, 125V, M5x15 (part # 45-00859-06R0)

Telecom Option - T1 Output

Four Outputs:

Signal Type:	AMI
Frequency:	1544kbps
Format:	Framed per G703/2,
Level	Per G703/10
Impedance/Connectors:	Two balanced 120 Ohm twin BNC
	Two unbalanced 75 Ohm, BNC

Two Outputs:

Signal Type:	Bipolar clock, >2.2Vp -p
Frequency :	1544kHz
Format:	Square wave
Impedance/Connectors:	Two unbalanced 75 ohm, BNC

Telecom Option - E1 Output

Four Outputs:

Signal Type:	AMI
Frequency:	2048kbps
Format:	Framed per G703/10
Level:	Per G703/10
Impedance/Connectors:	Two Balanced 120 ohm, twin BNC

Two Outputs

Signal Type:	Bipolar clock, >2.2Vp-p
Frequency:	2048kHz
Format:	Square wave
Impedance/Connectors:	Two Unbalanced 75 ohm, BNC

Appendix A - Programmer's Guide

In certain specialized applications, users may wish to develop customized interface and control software, rather than **Monitor3**. This section describes the protocol for the RS-232 Interface and includes general communication parameters as well as the command list. Note that this section is designed for experienced programmers and assumes a general knowledge of RS-232 interface programming.

A.1 General Parameters

The factory-default RS-232 settings, modifiable using the C05 command, are:

Configuration:	DTE
Baud Rate:	9600
Data Bits:	7
Parity:	Odd
Stop Bits:	2

A.2 Command Reference

Commands are sent to the **Cs4000** over the RS-232 port. The command set is backwards compatible with Symmetricom instruments based on the 4201A/5045 architecture (4040, 4065). Several new commands support the new capabilities of the Cs4000.

```
General format: <STX>_<Function Code>_<IDENT>_<DATA><ETX>
```

Element	**Description**
`STX`	002
_	Space character
`<Function Code>`	Function code, see table
`<IDENT>`	5 character unit identification number
`[<DATA>]`	Data: this string is of variable length
`ETX`	003

All entries in the data field are left justified, and the remainder (if any) of the Data field must be filled in, to round it up to 9 characters in length. All commands sent to the **Cs4000** return a response of the form:

```
<STX><Text of response><ETX>
```

Table 8 on page 48 lists the commands recognized by the **Cs4000**.

If the Cs4000 receives a malformed or non-compliant command or if the command addresses an optional feature which is not currently installed (i.e. commands which address features particular to other Symmetricom cesium instruments), the **Cs4000** performs no action and echoes the command back to the user with an additional space character and question mark character appended prior to the closing <ETX> character. For example:

Transmission:

`<STX>C05_00000_1900,8,N,1<ETX>` (*error in Baud rate datafield)*

Cs4000 Response:

`<STX>C05_00000_1900,8,N,1 ?<ETX>`

Table 8 defines the **Cs4000** interface.

WARNING… Many of the function codes listed in the following tables are labeled "Reserved for Factory Use" and are intended only for factory calibration and test of the Cs4000 instrument. Issuance of commands labeled "Reserved for Factory Use" may render the Cs4000 inoperable and void the warranty.

Table 8 Cs4000 Command Reference

CMD	Description	Data Field	See Section
W00	Reset alarms	No data required	4.7
W01	Set frequency offset (permanent, value is saved in NVRAM and restored on power up). The offset is in parts in 10-15	Sign plus 6 digits	4.3
W02	** Reserved for Factory Use **		
W03	Phase Offset (advance or retard 10 MHz phase by N nanoseconds)	Sign plus 4 digits	4.4
W04	Halt phase offset operation.	No data required	4.4
W05	** Reserved for Factory Use **		
W06	** Reserved for Factory Use **		
W08	** Reserved for Factory Use **		
W10	** Reserved for Factory Use **		
W11	Set Temporary frequency offset (not saved in NVRAM). The offset is in parts in 10-15	Sign plus 6 digits	
W12	** Reserved for Factory Use **		
W13	** Reserved for Factory Use **		
W14	** Reserved for Factory Use **		
W17	Alarm Relay Cutoff	No data required	
W18	** Reserved for Factory Use **		
W22	Arm 1 PPS Sync circuit. Issue this command after connecting a 1 PPS source to the Cs4000. The sync will remain armed for 3 seconds.	No data required	4.5
D*1	Return Variables (250 characters)	No data required	
D*2	Return Constants (145 characters)	No data required	
D*3	** Reserved for Factory Use **		
D*4	** Reserved for Factory Use **		
D*5	Return NVRAM Contents		
C01	** Reserved for Factory Use **		
C02	** Reserved for Factory Use **		
C03	Return software version	No data required	
C04	** Reserved for Factory Use **		
C05	Set serial port parameters	Baud, data, parity, stop bits	4.10
C06	** Reserved for Factory Use **		
S01	** Reserved for Factory Use **		
S02	** Reserved for Factory Use **		
S03	** Reserved for Factory Use **		
S04	** Reserved for Factory Use **		
S05	** Reserved for Factory Use **		
S06	** Reserved for Factory Use **		
S07	** Reserved for Factory Use **		
S08	** Reserved for Factory Use **		
S09	** Reserved for Factory Use **		
A01	** Reserved for Factory Use **		
A02	** Reserved for Factory Use **		

CMD	Description	Data Field	See Section
A03	** Reserved for Factory Use **		
A04	** Reserved for Factory Use **		
A05	** Reserved for Factory Use **		
A06	** Reserved for Factory Use **		
A07	** Reserved for Factory Use **		
A08	** Reserved for Factory Use **		
A09	** Reserved for Factory Use **		
A10	** Reserved for Factory Use **		
A11	** Reserved for Factory Use **		
A12	** Reserved for Factory Use **		
A13	** Reserved for Factory Use **		
A14	Return power on hours	No data required	
A15	** Reserved for Factory Use **		
A16	** Reserved for Factory Use **		
A17	** Reserved for Factory Use **		
A18	Set Restart Fault Level	1 = restart is critical fault 0 = restart not critical fault	4.7
A19	** Reserved for Factory Use **		
A20	** Reserved for Factory Use **		
A21	** Reserved for Factory Use **		
A22	** Reserved for Factory Use **		
A23	** Reserved for Factory Use **		
A24	** Reserved for Factory Use **		
B01	Set DCC Time	10 characters	4.10
B02	Retrieve DCC Time	10 characters	4.10
B03	Insert Seconds into DCC Time	Sign +5 digits	4.10
B10	Set T1 interface parameters	6 characters	4.6
B11	Set E1 interface parameters	19 characters	4.6
B12	Set Ethernet interface parameters	51 characters	
B20	Retrieve DCC-specific telemetry (39 characters)	No data required	
B21	Retrieve DCC-Firmware Version	No data required	
B30	Retrieve T1 interface parameters (8 characters)	No data required	
B31	Retrieve E1 interface parameters (21 characters)	No data required	
B32	Retrieve Ethernet interface parameters (53 characters)	No data required	

Commands B01 through B32 are only available on instruments with the DCC option (LCD touchscreen, controller, Ethernet port). Additional notes for Table 8:

W00 Clear Alarms

DCC clear its alarms and then retransmit W00 to cesium instrument.

Return Value: Echo of the command received.

C05 Set Serial Port parameters

DCC ignores reset baud rate to new value, ignore data, parity, and stop bits fields.

Return Value: "Setting Serial Parameters to *XXXX*,8,N,1" where *XXXX* is the new baud rate setting.

Example: “Setting Serial Parameters to 19200,8,N,1”

B01 Set DCC Time

Datafield is a 10-digit integer indicating time since the epoch (00:00:00 UTC, January 1, 1970), e.g. 00:00:00UTC, January 1, 2000 = 946684800.

DCC clock is to be set to this time.

Following setting of DCC clock, DCC is to issue update the cesium instrument event log clock by issuing an A06 Set event log date command followed by an A07 Set event log time command to the cesium instrument.

Return Value: Echo of the command received

B02 Retrieve DCC Time

Returns 10 digit integer indicating time since the epoch (00:00:00 UTC, January 1, 1970). Transmission of reply should occur immediately following the next 1 PPS interrupt received by the DCC and should indicate that epoch.

Return Value: 10-digit integer.

B03 Insert Seconds into DCC Time

Datafield is 6 ASCII characters representing a signed integer (range –99999 to +99999). DCC is to increment/decrement clock by integer number of seconds.

Following setting of DCC clock, DCC is to issue update the cesium instrument event log clock by issuing an A06 Set event log date command followed by an A07 Set event log time command to the cesium instrument.

Return Value: Echo of the command received.

B10 Set T1 interface Parameters

Datafield is 6 ASCII characters containing T1 interface parameter as follows:

$$\begin{Bmatrix} \mathrm{ES} \\ \mathrm{D4} \end{Bmatrix} < \mathrm{SP} > \begin{Bmatrix} \mathrm{SSM} \\ \mathrm{MUT} \\ \mathrm{AIS} \end{Bmatrix}$$

Where {} indicates optional choices and <SP> indicates space.

Return Value: Echo of the command received.

B11 Set E1 interface Parameters

Datafield is 19 ASCII characters containing T1 interface parameter as follows:

$$\mathrm{CRC4}\begin{Bmatrix} 0 \\ 1 \end{Bmatrix} < \mathrm{SP} > \mathrm{TS16}\begin{Bmatrix} 0 \\ 1 \end{Bmatrix} < \mathrm{SP} > \begin{Bmatrix} \mathrm{MUT} \\ \mathrm{SSM} \end{Bmatrix} < \mathrm{SP} > \mathrm{SSM\#}$$

Where:

- {} indicates optional choices and <SP> indicates space
- "#" following SSM should be replaced with the desired SSM level (typically 4-8)

Return Value: Echo of the command received.

B12 Set Ethernet interface Parameters

Datafield is 51 ASCII characters containing Ethernet interface parameters as follows:

$$\begin{Bmatrix}0\\1\end{Bmatrix} < SP > \begin{Bmatrix}0\\1\end{Bmatrix} < SP > XXX.XXX.XXX.XXX < SP > YYY.YYY.YYY.YYY < SP > ZZZ.ZZZ.ZZZ.ZZZ$$

Where:

- {} indicates optional choices and <SP> indicates space.
- The first field indicates whether or not the Ethernet port is enabled (1 = enabled).
- The second field indicates whether or not the DHCP is enabled (1 = enabled).
- XXX.XXX.XXX.XXX is the IP address of the instrument
- YYY.YYY.YYY.YYY is the network gateway
- ZZZ.ZZZ.ZZZ.ZZZ is the netmask

Note that all IP fields must be zero-padded to fill the complete 15-character width, i.e. "1.2.3.4" must be represented as "001.002.003.004."

Return Value: Echo of the command received.

B20 Retrieve DCC-Specific Telemetry

Return Value: 39-byte (37 +<STX><ETC>) DCC Telemetry String Defined in Table 11, below.

B21 Retrieve DCC Version Info

Return Value: 18-byte (16 +<STX><ETC>) string defined by:

<STX>A VVVV MM/DD/YY<ETX>

Where:

- A is a single alpha character
- VVVV is four numeric digits (e.g., 0001)
- MM/DD/YY is month/day/year

B30 Retrieve T1 interface Parameters

Return Value: 8 ASCII characters containing T1 interface parameter as follows:

$$<\text{STX}>\begin{Bmatrix}\text{ES}\\ \text{D4}\end{Bmatrix}<\text{SP}>\begin{Bmatrix}\text{SSM}\\ \text{MUT}\\ \text{AIS}\end{Bmatrix}<\text{ETX}>$$

Where {} indicates optional choices and <SP> indicates space.

B31 Retrieve E1 interface Parameters

Return Value: 21 ASCII characters containing E1 interface parameter as follows:

$$<\text{STX}>\text{CRC4}\begin{Bmatrix}0\\ 1\end{Bmatrix}<\text{SP}>\text{TS16}\begin{Bmatrix}0\\ 1\end{Bmatrix}<\text{SP}>\begin{Bmatrix}\text{MUT}\\ \text{SSM}\end{Bmatrix}<\text{SP}>\text{SSM\#}<\text{ETX}>$$

Where:

- {} indicates optional choices and <SP> indicates space
- "#" following SSM should be replaced with the desired SSM level (typically 4-8)

B32 Retrieve Ethernet interface Parameters

Return value: 53-byte (51 +<STX><ETC>) string defined by:

$$<\text{STX}>\begin{Bmatrix}0\\ 1\end{Bmatrix}<\text{SP}>\begin{Bmatrix}0\\ 1\end{Bmatrix}<\text{SP}>\text{XXX.XXX.XXX.XXX}<\text{SP}>\text{YYY.YYY.YYY.YYY}<\text{SP}>\text{ZZZ.ZZZ.ZZZ.ZZZ}<\text{ETX}>$$

Where:

- {} indicates optional choices and <SP> indicates space.
- The first optional choice indicates whether the Ethernet port is enabled (1 = enabled).
- The second field indicates whether or not the DHCP is enabled (1 = enabled).
- XXX.XXX.XXX.XXX is the IP address of the instrument
- YYY.YYY.YYY.YYY is the network gateway
- ZZZ.ZZZ.ZZZ.ZZZ is the netmask

Table 9 Data returned by the "Return Variables" command D*1

Variable	Field	Example
STX CR LF	1-3	
Unit serial number	4-10	ID00025
Space	11	
Day Meter	12-14	537
Space	15	
Time (hour minute second)	16-25	16h13mn22s
Space	26	
First or second order servo loop	27	1
Space	28	
Operating mode	29-31	R+Z
Space	32	
Alarms state	33-54	ALM:00(00,00,00,00,00)
C-Field adjustment	55-59	C +015
Space	60	
Frequency fine tuning	61-68	F –006
Space	69	
+21VDC power supply	70-76	+24.8V
Space	77	
Filtering time constant (seconds)	78-83	Ct05.0
CR LF	84-85	
Clock servo voltage difference	86-90	R–019
Clock pedestal servo voltage difference	91-98	RR +0045
Zeeman servo voltage difference	99-103	Z+008
Zeeman pedestal servo voltage difference	104-111	RZ –0004
Oscillator servo output voltage	112-118	AR–0029
Clock peak to background level difference	119-124	PR2506
Zeeman servo output voltage	125-131	AZ+0007
Zeeman peak to background level difference	132-137	PZ1765
Preamplifier DC level servo output voltage	138-144	A0 + 0690
Numerical gain	145-151	GN*1.53
Clock (Ramsey) peak symmetry check	152-158	LA–0005
Microwave power servo control voltage	159-165	Pu–2875
CR LF	166-167	
+5V power supply	168-173	+5.08V
Space	174	
Internal case temperature in degrees Celsius	175-180	T+27.7
Space	181	
+15.5V power supply	182-187	+15.1V
Space	188	
–15.5v power supply	189-194	–16.2V
Quartz oscillator cold/warm	196-198	Olc
Space	199	
Cesium oven supply voltage	200-205	F008.0
Space	206	
Mass spectrometer voltage	207-212	VS18.9
Space	213	
Cesium beam tube Ionizer voltage	214-219	VF1.05
Space	220	
C-Field coil current	221-226	IC14.5
Space	227	
HTEM control voltage	228-233	HT10.6

Space	234	
Ion Pump current	235-239	IP025
Space	240	
Allan deviation of clock servo voltage over 30 seconds	241-247	+137 mV
CR LF ETX	248-250	

Table 10 Data returned by the "Return Constants" command D*2

Variable	Field	Example
STX CR LF	1–3	
Unit serial number	4–10	ID00025
Space	11	
Day Meter	12–14	006
Space	15	
Time (hour minute second)	16–24	04h54mn32s
Space	25	
Spectrometer voltage nominal	26–33	Vs 14.0V
Space	34	
Tube ionizer voltage nominal	35–42	Vf 1.07V
Space	43	
Gain DAC	44–51	GDAC 008
Space	52	
F(t°) correction model at –15°C	53–59	–15:+10
Space	60	
F(t°) correction model at +15°C	61–67	+15:+00
Space	68	
F(t°) correction model at +45°C	69–75	+45:–03
Space	76	
F(t°) correction model at +75°C	77–83	+75:+04
CR LF	84–85	
12.6 MHz level nominal (J1 max)	86–92	Pi+0345
Space	93	
Zeeman offset (Asymmetry compensation)	94–100	Oz–0045
Space	101	
Auxiliary output signal frequency	102–112	Fo:05.0 MHz
Space	113	
Console mode language	114–119	CDU: UK
Space	120	
Comments	121–133	TXT(1234567890)
Space	134	
Space	135	
program version	136–138	370
Space	139	
program revision	140–142	1.8
CR LF ETX	143–145	

Table 11 Data returned by the "Retrieve DCC Specific Telemetry" Command B20

Variable	Field	Example
STX	1	
Alarm State	2-5	0000
Space	6	
System 24 VDC	7-11	24.34
Space	12	
AC Supply 24 VDC	13-17	24.02
Space	18	
DC Input 24 VDC	19-23	23.95
Space	24	
Battery 24 VDC	25-29	23.50
Space	30	
Charging Current	31-34	0035
Space	35	
Power Mode	36-37	"AC", "DC", or "BT"
Space	38	
ETX	39	

Event Log

A portion of the non-volatile memory in the system is reserved for storage of event records. Event records consist of a time stamp and an event mask. Any change in the system status is recorded as a new event in the log. The event log can be cleared by an external command. Because the Cs4000 lacks a battery-backed real time clock, the Event log stores two distinct time stamps. The first is a 6-byte calendar date; the second is a 32-bit value representing the total system power on hours.

Appendix B - Symmetricom Customer Assistance (Technical Support)

For assistance, contacting us as follows:

Email:	support@symmetricom.com
Web:	http://www.symmetricom.com/support
USA toll-free:	**1-888-367-7966** (1-888-FOR-SYMM)
USA, Canada, Latin America, Caribbean, Pacific Rim, Asia, Australia, and New Zealand:	**1-408-428-7907**
Europe, Middle East & Africa:	**49 700 3288-6435**
Worldwide (Main Number):	**1-408-428-7907**

Appendix C - Using the LCD Touchscreen

The optional LCD touchscreen provides functions for monitoring and configuring the Cs4000 directly from the Cs4000's front panel.

The touchscreen illuminates shortly after power is applied to the instrument. A linux penguin is visible for about 30 seconds, followed by the main Time Display shown in Figure 27.

Figure 27 The Time Display

The Time Display provides the following three elements:

- The **Menu Bar**, which provides access to the instrument's functions, is hidden by default and appears when the user presses the touchscreen.
- The **Day or Year** and **Time of Day** in white characters (which remain flashing until the user has entered the date (see **System – Set Date** below).
- The **Status Bar** at the bottom of the screen.

Note: The following convention indicates a menu item: **<menu> - <menu item>**. For example, the **Set Date** item in the **System** menu is shown as follows:

System – Set Date

Within a given function (display window), click the **Cancel** button at any time to exit the function without applying changes.

C.1 The Menu Bar

Figure 28 The menu bar with the System menu open

By default, the menu bar is hidden. Press the touchscreen to display the menu bar. The menu bar will be hidden again after a period of inactivity (30 seconds, by default). To adjust the period of time before the menu bar is hidden, or to make the menu bar permanently visible, use the **System – Menu Timer** function.

The menu bar provides access to all of the menus for configuring and monitoring the Cs4000, summarized in the following list:

- System
  - Set Time of Day
  - Set Date
  - Adjust Time of Day
  - Menu Timer
  - Backlight
  - Factory Settings
  - Calibrate Screen
- View
  - Power Supplies
  - System 24V
  - CBT Supplies
  - Clock & Zeeman Servo
  - Gain & uWave Servos
  - Alarms
  - Event Log
  - System Information

- Outputs
  - Delta-F
  - Delta-T
  - Sync 1 PPS
- COMM
  - Ethernet
  - RS-232
  - Security
  - E1 (if present)
  - T1 (if present)

C.2 Day of Year and Time of Day

When the instrument is powered up, the Day of Year and Time of Day flash until a user manually sets the Day of Year using the **System – Set Date** function.

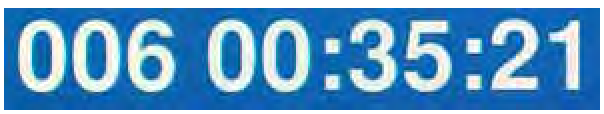

Figure 29 The Time Display showing

The Day of Year and Time of Day is displayed in the DOY HH:MM:SS format, where DOY is the day of the year (001-365), HH is the hour of the day (00-23), MM is the minute of the hour (00-59), and SS is the seconds of the minute (00-59).

Use the **System – Set Date** function to set DOY. Use the **System – Set Time Of Day** function to set HH:MM:SS.

To synchronize the Time of Day with an external time reference, connect a 1 PPS signal to one of the 1 PPS SYNC inputs and use the **Outputs – Sync 1 PPS** function.

If Time of Day is synchronized with UTC, the user must perform leap second adjustments manually using the **System – Adjust Time Of Day** function.

C.3 The Status Bar

Figure 30 The Status Bar

The status bar displays the following items:

- **Alarm** (See "Alarms", on page 73):
  - Red: One or more alarms are pending
  - Dark: No pending alarms

- **Lock** (See "Alarms", on page 73):
  - Dark: Instrument is not operating within specifications (e.g., warming up)
  - Green: The unit is operating within specifications

- **Power source**: AC, DC, or BT (battery). (See section "2.4 Power" on page 6.)

Additionally, the menu bar shows the Day or Year and Time of Day while a function is being displayed and the main Time Display isn't visible.

C.4 The System Menu

C.4.1 Set Time of Day

Figure 31 Set Time of Day

To set the time of day:

1. Select the **System – Set Time Of Day** function from the menu bar.
2. Enter the Time Of Day as HH:MM:SS where HH is the hour of the day (00-23), MM is the minute of the hour (00-59), and SS is the seconds of the minute (00-59).
3. Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.2 Set Date

Figure 32 Set Date

To set the date:

1. Select the **System – Set Date** function from the menu bar.
2. Enter the date as MM/DD/YYYY where MM is the month of the year (01-12), DD is the day of the month (01-31), and YYYY is the year.
3. Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.3 Adjust Time of Day

Figure 33 Adjust Time of Day

To adjust the Time of Day or the Day of Year:

1. Select the **System – Adjust Time of Day** function from the menu bar.
2. Press the up or down arrows to increment or decrement the corresponding value by one.
3. Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.4 Menu Timer

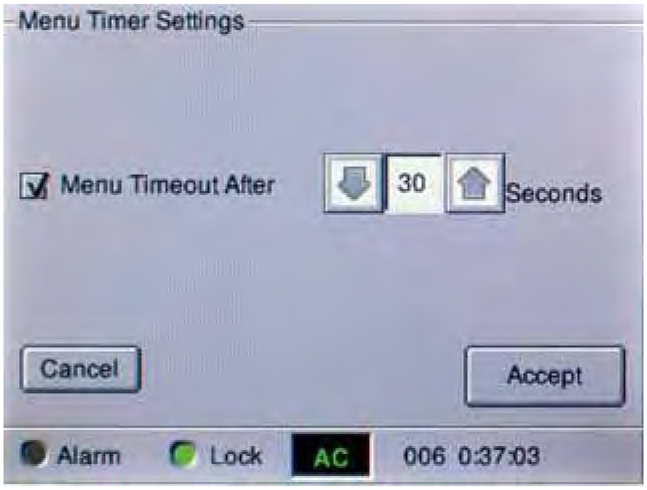

Figure 34 Menu Timer

This function specifies how long the menu bar remains visible, automatically hiding it after a specified period of inactivity.

- To disable the auto-hide feature of the menu bar on the main Time Display, de-select (uncheck) the **Menu Timeout After** checkbox.
- To enable the auto-hide feature of the menu bar on the main Time Display, select (check) the **Menu Timeout After** checkbox. This setting also affects how long the backlight remains on if the user activates the backlight while it is scheduled to be off.
- Use the up or down arrows to adjust the length of time (inactivity) before the menu bar is automatically hidden.
- Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.5 Backlight

This feature turns the LCD touchscreen's backlight ***off and on*** according to daily schedule, improving the lifespan of the touchscreen. When enabled, this feature turns the LCD off and back on at the specified times.

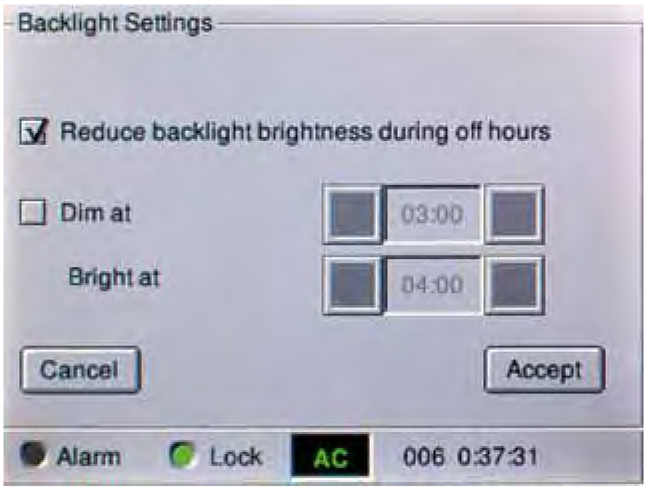

Figure 35 Backlight Settings

Note: Touching the screen shortly before the **Dim at** time can delay the backlight from turning off by a number of seconds.

- To enable this feature, select (check) the checkbox for **Reduce backlight brightness during off hours**. To disable this feature, deselect (uncheck) the checkbox.
- To adjust the daily off and on schedule, select (check) the checkbox next to **Dim at** and use the up and down arrows to adjust the **Dim at** and **Bright at** times by whole hours (no minute or second adjustments are available). Once these changes have been applied, the **Dim at** checkbox is automatically deselected (unchecked) to prevent unintentional changes to the schedule.
- To turn the backlight on temporarily while it is off, press the touchscreen. The backlight will remain on for the duration specified by the **Menu Timeout After** setting in the **System - Menu Timer** function (even if **Menu Timeout After** is disabled).
- Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.6 Factory Settings

Use this function to adjust the Loop Tau or to change the unit's Serial Number.

Figure 36 Factory Settings

> **NOTE…**
> Changing Loop Tau is not advisable except by knowledgeable persons. See section "4.9 Factory Settings" on page 22 for more information.

- To change Loop Tau, click the **Adjust** button and enter the new Loop Tau value.
- To change the Serial Number, click the **Adjust** button and enter a new number.
- Press the **Accept** button to apply the changes, or press the **Cancel** button to clear the changes and return to the main Time Display.

C.4.7 Calibrate Screen

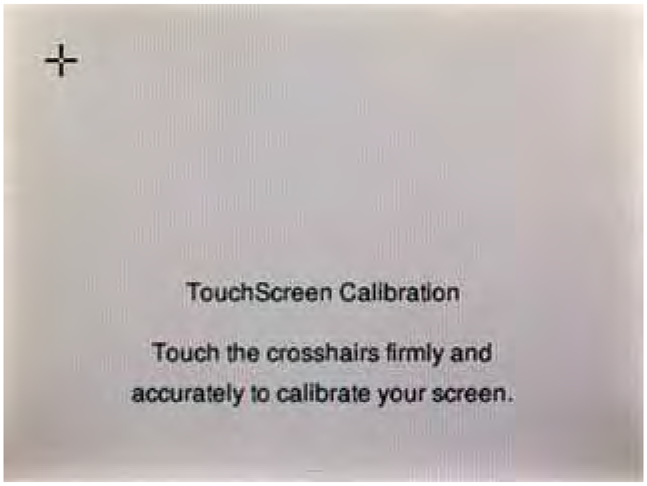

Figure 37 Calibrate Screen

This function calibrates the touchscreen so the elements of the user interface align correctly with user inputs (pressure applied to the screen). This ensures correct operation when the user presses menus and buttons in the touchscreen's user interface.

To calibrate the screen, press the crosshairs each time it is displayed in a corner of the touchscreen. The calibration process repeats automatically if any of the entries are significantly out of alignment. When the calibration process is complete, the function automatically returns to main time display.

C.5 The View Menu

Figure 38 View Menu

C.5.1 Power Supplies

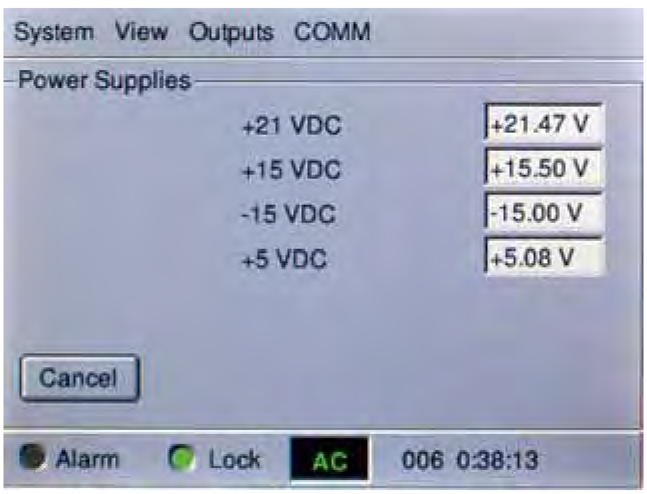

Figure 39 Power Supplies

This function displays the voltage levels of the instrument's internal power supplies:

- +21 VDC
- +15 VDC
- -15 VDC
- +5 VDC

C.5.2 System 24V

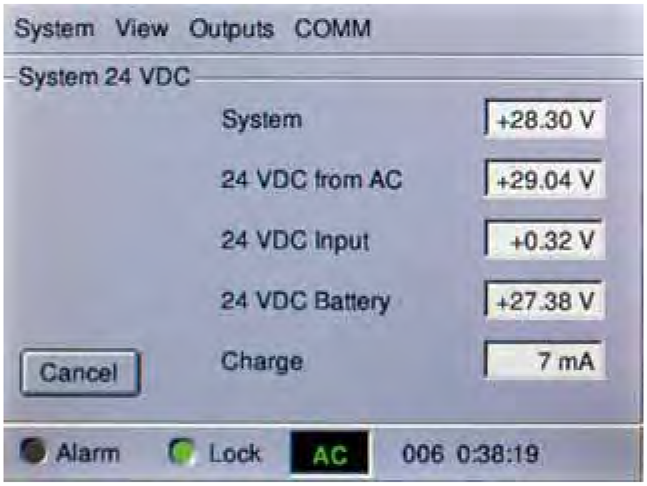

Figure 40 System 24 VDC

This function displays the following information for the instrument's external 24 VDC power supply:

- System: the total voltage of the internal 24 VDC circuit
- 24 VDC from AC: the voltage of the AC power supply
- 24 VDC Input: the voltage of the External 24 VDC input
- 24 VDC Battery: the voltage of the internal battery back-up option
- Charge: Battery charging current

C.5.3 CBT Supplies

Figure 41 CBT Supplies (CBT Voltage)

This function displays the following Cesium Beam Tube (CBT) voltage and related information:

- OCXO Oven
- Cesium Oven
- EM Voltage
- Ion Pump
- C-Field
- Ionizer
- Mass Spec

See Table 4 on page 15 for more information.

C.5.4 Clock & Zeeman Servo

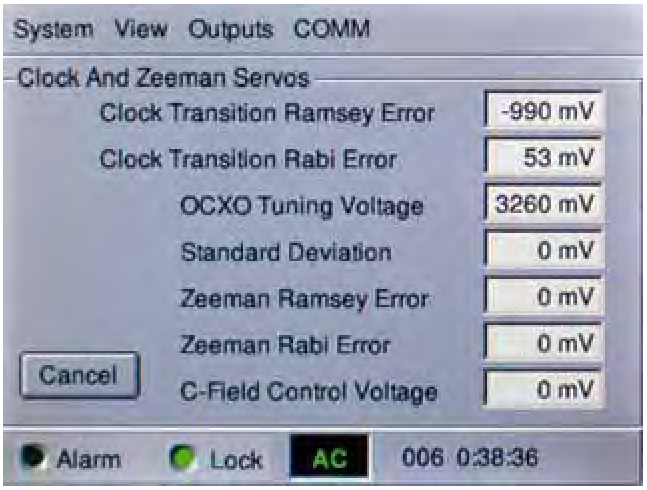

Figure 42 Clock & Zeeman Servos

This function displays the following Clock and Zeeman Servo information:

- Clock Transition Ramsey Error
- Clock Transition Rabi Error
- OCXO Tuning Voltage
- Standard Deviation
- Zeeman Ramsey Error
- Zeeman Rabi Error
- C-Field Control Voltage

See Table 4 on page 15 for more information.

C.5.5 Gain & uWave Servos

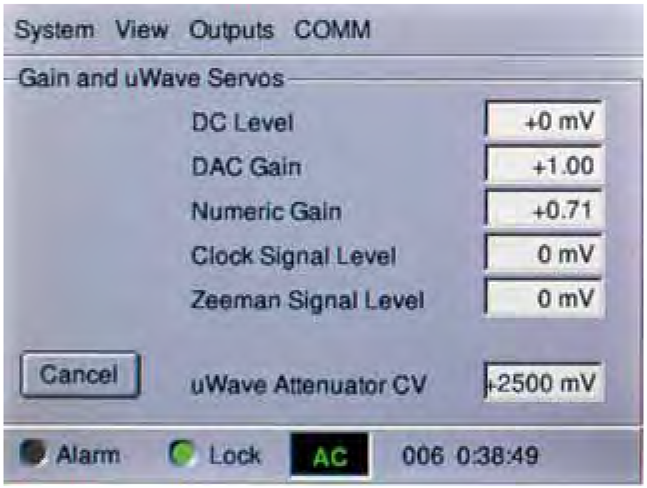

Figure 43 Gain & uWave Servos

This function displays the following Gain and uWave Servo information:

- DC Level
- DAC Gain
- Numeric Gain
- Clock Signal Level
- Zeeman Signal Level
- UWave Attenuator CV

See Table 4 on page 15 for more information.

C.5.6 Alarms

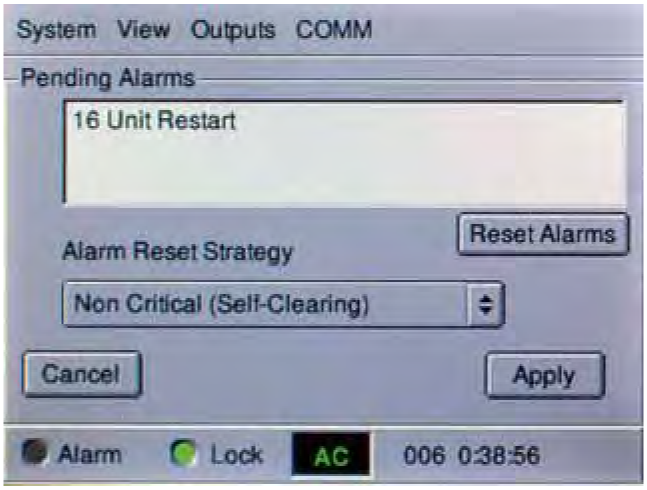

Figure 44 Alarms

This functions displays a list of Pending Alarms. See Table 7 on page 41 for more information about alarms.

Reset Alarms button: Pressing this button clears the list of pending alarms. Any current alarm conditions will reappear after a few moments.

See section "4.7 Alarms" on page 19 for more information.

C.5.7 Event Log

Figure 45 Event Log

The Event Log function displays a list of all system events.

- Event Count: This window displays the total number of events in the Event Log.
- Event Log (not labeled): The event log displays a list of all the system events.
- Clear Instrument button: This button clears all information from the Event Log.

See Section 4.8 on page 20 for more information.

C.5.8 System Information

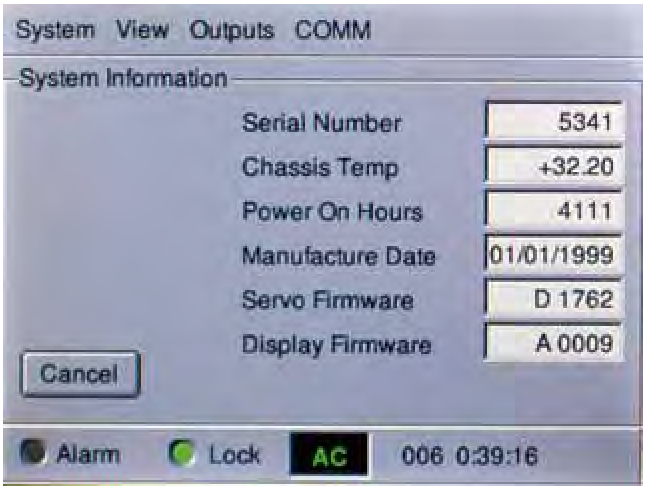

Figure 46 System Information (Event Log)

The System Information function displays the following information:

- Serial Number
- Chassis Temperature (in degrees Celsius)
- Power On Hours
- Manufacture Date
- Servo Firmware
- Display Firmware

See Section 4.1 on page 13 for more information.

C.6 The Outputs Menu

Figure 47 Outputs Menu

C.6.1 Delta-F (Adjust Output Frequency)

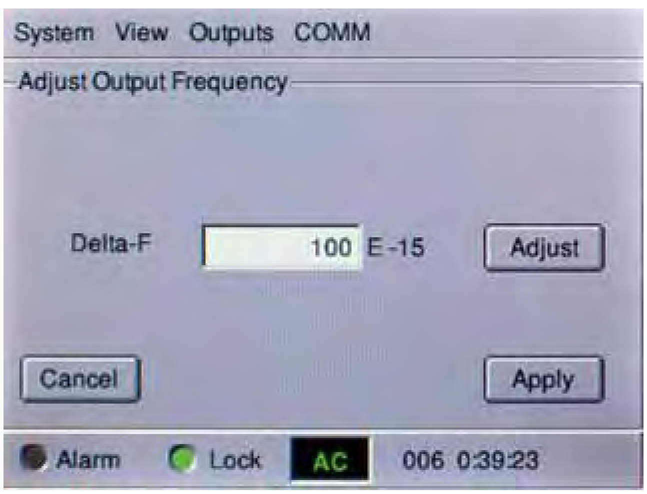

Figure 48 Delta-F (Adjust Output Frequency)

Use the Delta-F function to adjust the instrument's output frequencies. See Section 4.3 on page 16 for more information.

1. To adjust the output frequency, click the **Adjust** button. This displays a numeric keypad.
2. Enter the new value and click the **Accept** button.
3. Click the **Apply** button to change the setting, or click the **Cancel** button to discard the changes and return to the main Time Display.

See "Adjusting Output Frequency" on page 16 for more information.

C.6.2 Delta-T (Slew Output Phase)

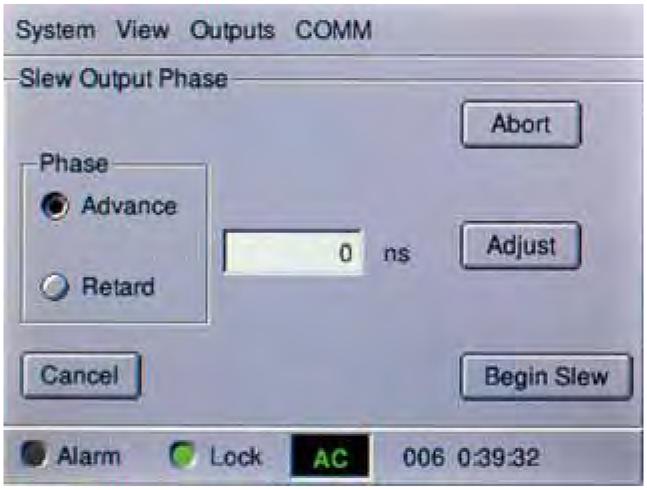

Figure 49 Delta-T (Slew Output Phase)

To slew the output phase:

1. In the Phase selection box, select to **Advance** or **Retard**.
2. Click the **Adjust** button. This displays a numeric keypad.
3. Enter the new value in nanoseconds (nS), and click the **Accept** button.
4. To commence the slewing process, click the **Begin Slewing** button. To abort a slewing process that already in progress, click the **Abort** button.

See “Slewing the Output Phase” on page 16 for more information.

C.6.3 Sync 1 PPS

To synchronize the 1 PPS outputs and Time of Day with a 1 PPS input signal, attach a 1 PPS source to one of the **1 PPS Sync** input connectors (located on the front or rear panels) and press the **SYNC** button.

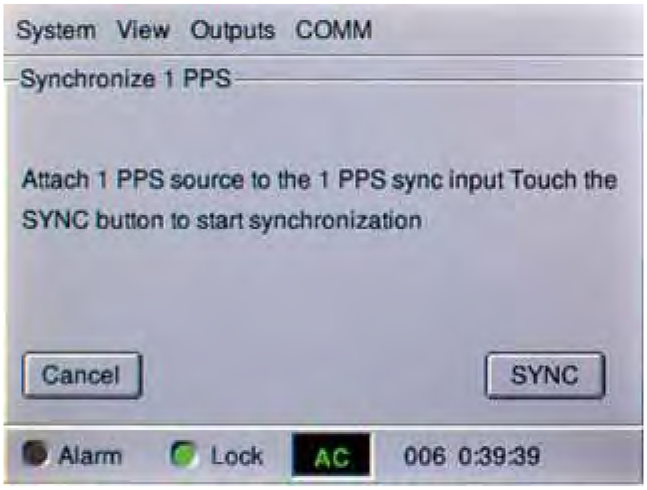

Figure 50 Synchronize 1 PPS

See Section 4.4 on page 16 for more information.

C.6.4 E1 Framing

The E1 function only appears if the E1 option is present.

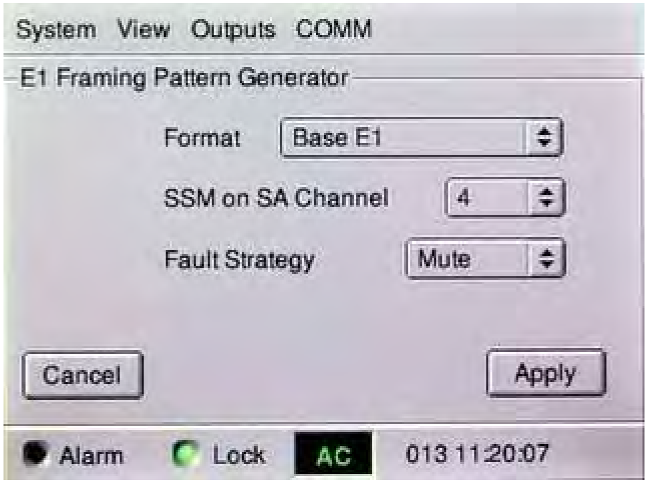

Figure 51 E1 Framing Pattern Generator

See "E1 Framing Pattern Generator" on page 18 for more information.

C.6.5 T1 Framing

The T1 function only appears if the T1 option is present.

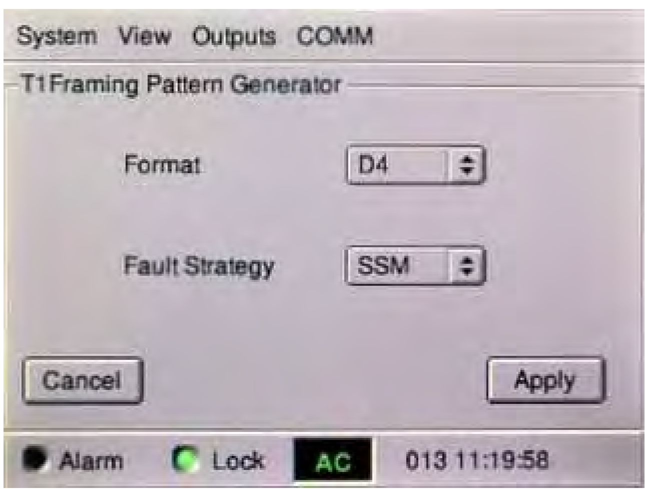

Figure 52 T1 Framing Pattern Generator

See "T1 Framing Pattern Generator" on page 19 for more information.

C.7 The COMM Menu

The COMM menu provides functions related to the RS-232 and Ethernet ports.

Figure 53 COMM (Communications) Menu

C.7.1 Ethernet

Figure 54 Ethernet Settings

To configure the IP Address, Net Mask, or Gateway settings for the LAN port on the rear panel:

1. Click the **Adjust** button. This displays a numeric keypad.
2. Enter a new value and click the **Accept** button.
3. Click the **Apply** button.

To obtain these settings automatically using DHCP, select (check) the **Use DHCP** checkbox, and click the **Apply** button.

C.7.2 RS-232

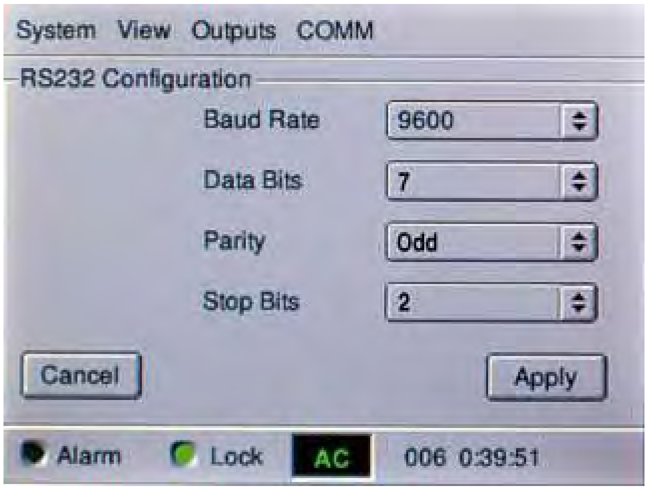

Figure 55 RS-232 Settings

To configure the Baud Rate, Data Bits, Parity, and Stop Bits settings for the RS-232 port on the rear panel, select the new value using the pull-down menus and click the **Apply** button.

The default configuration is: **9600, 7, Odd, 2**

See "Establishing Communications" on page 11 for more information.

C.7.3 Security

Figure 56 Security Settings

To enable or disable the LAN (Ethernet) port on the rear panel, select (enable) or deselect (disable) **Ethernet Port Enabled** and click the **Apply** button.

Please note that the sole function of the Ethernet port is to provide remote access to a web page of Cs4000 status. No functions for configuring the instrument are provided on the Ethernet port.

Appendix D - Cs4000 Web Interface and LAN Network Port

The DCC/LCD touchscreen option automatically generates a web page of Cs4000 status information (see Figure 57) and makes it available from the “LAN” network port on the rear panel. This page is known as the *Cs4000 Web Interface*. Please note that, for security, the Cs4000 Web Interface is “read-only” and cannot be used to configure the instrument.

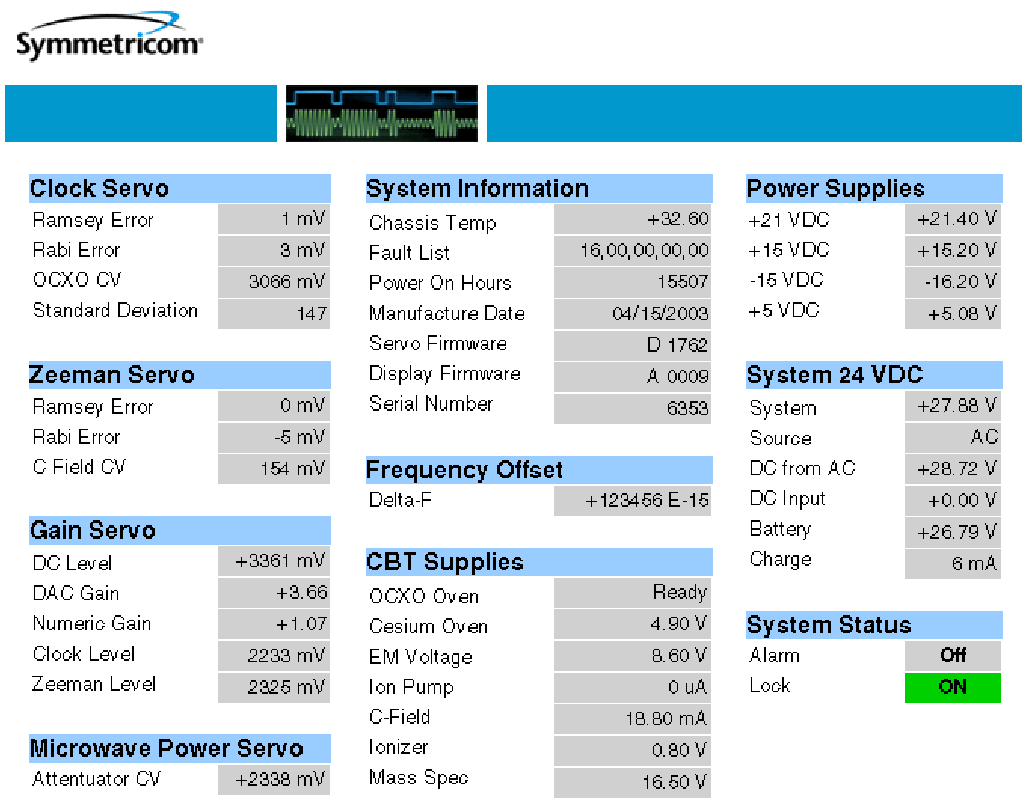

Figure 57 Cs4000 Web Interface

To view the Cs4000 Web Interface, a user configures the instrument’s LAN network port using the LCD touchscreen or the Monitor3 software (supplied with the instrument), and then connects to it using a browser.

To configure the network port using the LCD touchscreen:

1. Select the **Ethernet** menu item from the **COMM** menu.
2. Enter the appropriate values for **IP Address**, **Netmask**, and **Gateway**, or select (check) the **Use DHCP** check box.
3. Click the **Apply Changes** button.
4. Check the setting of the **Security** menu item in the **COMM** menu. If needed, enable the network port.

To configure the network port using Monitor3:

1. Select the **Ethernet** menu item from the **System** menu.
2. Deselect (uncheck) **Disable Ethernet Port**.
3. Enter the appropriate values for **IP Address**, **Netmask**, and **Gateway**, or select the **Use DHCP** checkbox.
4. Click the **Apply Changes** button.

If needed, please obtain valid network address values from a network administrator.

After configuring the network port, enter the instrument's *IP address* in the browser's address field to view the Cs4000 Web Interface, as shown in Figure 58.

Figure 58 Entering an IP address (example address)

D.1 Security Statement for Network Port

The Cs4000 was designed to provide a secure network access point for monitoring the health and status of the Cs4000 Cesium Clock in commercial or laboratory environments.

The communications interface system is based on a discrete CPU card that interfaces with the internal Cesium subsystem via a well-defined serial interface. The CPU card runs a specialized distribution of the Linux operating system designed for use in embedded systems of this type. All network services and access ports not required for the proper operation of the CPU card have been either removed or disabled. Specifically, network based shell access of any type is disabled in the Cs4000. Access to status information via the network is restricted to the embedded GoAhead web server. This web server package is specifically designed to provide a robust, secure web server interface. To further protect the integrity of the Cs4000, the interface has designed using a read-only paradigm. No Cs4000 settings may be changed via the network interface.

Verification of the proper implementation of the web interface was performed using industry standard tools including ISIC (Internet Stack Integrity Checker) and Nessus (Network Vulnerability Scanner).

Contact the Symmetricom if additional information is required.

Chapter 8 - Certificate of Conformance

Please consult the following page.

CHOMERICS TEST SERVICES
77 Dragon Court
Woburn, Massachusetts 01801

CERTIFICATE OF CONFORMANCE

Date of Issue:	January 30, 2006
Issued To:	Symmetricom Inc. 34 Tozer Road Beverly, Massachusetts 01915-5510
Reference:	Chomerics Test Services Test Report Numbers EMI4241.05, EMI4410.05 and SAF4410.05

Chomerics Test Services hereby acknowledges that EMC and Safety testing was performed in accordance with the standards as listed below. **Chomerics Test Services** further acknowledges that the test sample as described within this certificate was found to be in compliance with these standards. This certificate is hereby issued to **Symmetricom Inc.** and is valid only for the equipment and standards as described within this certificate. For further details regarding the equipment under test, reference Chomerics Test Services Test Report Numbers EMI4241.05, EMI4410.05 and SAF4410.05.

Manufacturer: Symmetricom Inc.
Equipment Tested: Cesium 4000 (AC / DC)

EU EMC Directive 89/336/EEC:

EN55022 Class B	Limits and methods of measurement of electromagnetic disturbance characteristics of information technology equipment (ITE)	
EN61000-3-2	Limits for harmonic current emissions (equipment input current ≤ 16A per phase)	
EN61000-3-3	Limitation of voltage fluctuations and flicker in low voltage supply systems for equipment with rated current ≤ 16A	
EN55024 (1998)	Information technology equipment -Immunity characteristics - Limits and methods of measurement	
	EN61000-4-2 (1995)	Electrostatic discharge immunity
	EN61000-4-3 (1997)	Radiated, radio-frequency, electromagnetic field immunity
	ENV50204 (1996)	Radiated electromagnetic field from digital radio telephones immunity
	EN61000-4-4 (1995)	Electrical fast transient/burst immunity
	EN61000-4-5 (1995)	Surge Immunity
	EN61000-4-6 (1996)	Immunity to conducted disturbances, induced by radio-frequency fields
	EN61000-4-8 (19943)	Power frequency magnetic field immunity
	EN61000-4-11 (1994)	Voltage dips, short interruptions and voltage variations immunity

Low Voltage Directive 73/23/EEC

EN61010-1:2001 — Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1 General Requirements

For Chomerics Test Services: Date:

David C. Inman (signature) 1/30/06

David C. Inman, Manager

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