

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*



CSIII (Model 4310B) User's Guide

© 2021 Microchip Technology Inc.

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods being used in attempts to breach the code protection features of the Microchip devices. We believe that these methods require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Attempts to breach these code protection features, most likely, cannot be accomplished without violating Microchip's intellectual property rights.
- Microchip is willing to work with any customer who is concerned about the integrity of its code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable." Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication is provided for the sole purpose of designing with and using Microchip products. Information regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL LOSS, DAMAGE, COST OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, Inter-Chip Connectivity, JitterBlocker, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2021, Microchip Technology Incorporated, All Rights Reserved.

ISBN: 978-1-5224-7867-6

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.

PURPOSE OF THIS GUIDE

The CSIII user guide provides basic recommendations for use of Microchip's CSIII 4310B cesium reference.

WHO SHOULD READ THIS GUIDE

This document is intended for engineers and technicians who have purchased the CSIII and need to understand how to operate the product.

DOCUMENT LAYOUT

This guide contains the following sections:

- **Chapter 1. "Product Overview"**: Provides an overview of the product, describes the major hardware and software features, and lists the system specifications.
- **Chapter 2. "Installation"**: Contains the Principle of Operation, Start-Up Sequence, and aspects related to first power-up.
- **Chapter 3. "Operation"**: Provides an overview of the telemetry interface and command structure.
- **Chapter 4. "Maintenance and Troubleshooting"**: Contains information on required maintenance, troubleshooting, shipping and cesium tube replacement.
- **Chapter 5. "Theory of Operation"**: Explains principals of operation.
- **Appendix A. "Specifications"**: Refers to latest product specifications in product data sheet DS00003499.
- **Appendix B. "Programmer's Guide"**: This section describes the protocol for the RS-232 interface and includes general communication parameters and the command list. Note that this section is designed for experienced programmers and assumes a general knowledge of RS-232 interface programming.
- **Appendix C. "Customer Assistance/Technical Support"**: This appendix contains information about contacting Microchip using support services.

© 2021 Microchip Technology Inc.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

© 2021 Microchip Technology Inc.

WARNINGS, CAUTIONS, RECOMMENDATIONS, AND NOTES

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this guide. The types of information included in each are displayed in a style consistent with the examples below.

WARNING

To avoid serious personal injury or death, do not disregard warnings. All warnings use this style. Warnings are installation, operation, or maintenance procedures, practices, or statements, that if not strictly observed, may result in serious personal injury or even death.

CAUTION

To avoid personal injury, do not disregard cautions. All cautions use this style. Cautions are installation, operation, or maintenance procedures, practices, conditions, or statements, that if not strictly observed, may result in damage to, or destruction of, the equipment. Cautions are also used to indicate a long-term health hazard.

Note: All notes use this style. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information, which may make your task easier or increase your understanding.

WHERE TO FIND ANSWERS TO PRODUCT AND DOCUMENT QUESTIONS

For additional information about the products described in this guide, please contact your Microchip representative or your local sales office. You can also contact us on the web at www.microsemi.com/ftdsupport.

When this manual is updated the latest version will be available for downloading from Microchip's web site. Manuals are provided in PDF format for ease of use. After downloading, you can view the manual on a computer or print it using Adobe Acrobat Reader.

Manual updates are available at: www.microsemi.com/ftdsupport

RELATED DOCUMENTS AND INFORMATION

See your Microchip representative or sales office for a complete list of available documentation. To order any accessory, contact the Microchip Sales Department. See www.microsemi.com/sales-contacts/0 for sales support contact information. If you encounter any difficulties installing or using the product, contact Microchip Frequency and Time Systems (FTS) Services and Support:

U.S.A. Call Center: including Americas, Asia and Pacific Rim

Frequency and Time Systems

3870 N 1st St.

San Jose, CA 95134

Toll-free in North America: 1-888-367-7966

Telephone: 408-428-7907

Fax: 408-428-7998

email: ftd.support@microsemi.com

Internet: www.microsemi.com/ftdsupport

Europe, Middle East, and Africa (EMEA)

Microchip FTS Services and Support EMEA

Altlaufstrasse 42

85635 Hoehenkirchen-Siegertsbrunn

Germany

Telephone: +49 700 3288 6435

Fax: +49 8102 8961 533

email: ftd.emeasupport@microsemi.com

email: ftd.emea_sales@microsemi.com

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the website at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (December 2020)

- Initial release of this document as Microchip DS50003057A.
  - Under Microsemi's literature system, this document was 900-00509-000, rev B.

© 2021 Microchip Technology Inc.

Table of Contents

Preface 3
Purpose of This Guide 3
Who Should Read This Guide 3
Document Layout 3
Conventions Used in this Guide 4
Warnings, Cautions, Recommendations, and Notes 5
Where to Find Answers to Product and Document Questions 5
Related Documents and Information 5
The Microchip Website 6
Customer Support 6
Document Revision History 6
Chapter 1. Product Overview 9
1.1 Introduction 9
1.2 LED Indicators 9
1.3 Rear Panel Connections 9
1.4 Software 10
1.5 Power 10
1.6 Factory Configurations 10
Chapter 2. Installation 11
2.1 Installation 11
2.2 Unpacking Instructions 11
2.3 Environmental Considerations 11
2.4 Pre-Installation Checklist 11
2.5 Tools and Materials 12
2.6 Installing the CsIII 12
2.7 Installing the Monitor3 Software 13
2.8 Establishing Communications 13

© 2021 Microchip Technology Inc.

Chapter 3. Operation 15
3.1 Monitor3 main Status Window 15
3.2 Unit Monitoring and Data Logging 16
3.3 Adjusting Output Frequencies 18
3.4 Synchronizing to a 1PPS Source 18
3.5 Slewing the Output Phase 19
3.6 Alarms 20
3.7 Event Logging 21
3.8 Factory Settings 21
3.9 Communications 22
Chapter 4. Maintenance and Troubleshooting 23
4.1 Preventive Maintenance 23
4.2 Troubleshooting 24
4.3 Shipping 24
4.4 Hazardous material (HAZMAT) Shipping Considerations 24
4.5 Shipping Products Back to the Factory 24
4.6 Shipping Carriers 25
4.7 Storage 25
4.8 Cesium Beam Tube Vacuum 25
4.9 Cesium Beam Tube Shelf Life 25
Chapter 5. Theory of Operation 27
5.1 Cesium beam Frequency Standard Concept 27
5.2 Cesium Beam Tube 28
5.3 Clock Servo 32
5.4 Zeeman Servo 33
5.5 Gain Servo 33
5.6 Microwave Power Servo 34
5.7 Unit Initialization 35
5.8 Alarms and Indicators 36
Appendix A. Specifications 37
A.1 Alarm Interface 37
A.2 Options 37
Appendix B. Programmer's Guide 39
B.1 General Parameters 39
B.2 Restart Message 39
B.3 Cesium Command Reference 40
B.4 Event Log 45
Appendix C. Customer Assistance/Technical Support 47
Worldwide Sales and Service 49

© 2021 Microchip Technology Inc.

Chapter 1. Product Overview

1.1 INTRODUCTION

The Microchip CsIII Cesium Beam Frequency Standard is designed for high-precision timing and frequency applications requiring high stability, low-noise RF, and 1PPS reference signals. The CsIII comes in a standard 19-inch wide rack mount housing. It is 2U high (3.75") and weighs 28 lbs (12.7 kg). For more information, see **Appendix A. "Specifications"**.

1.2 LED INDICATORS

The following indicators are available on both the front and the rear panel.

- Power Indicator - Indicates power applied to instrument (green LED)
- Lock Indicator - Indicates normal operation (green LED)
- Alarm Indicator - Indicates unit alarm condition (red LED)

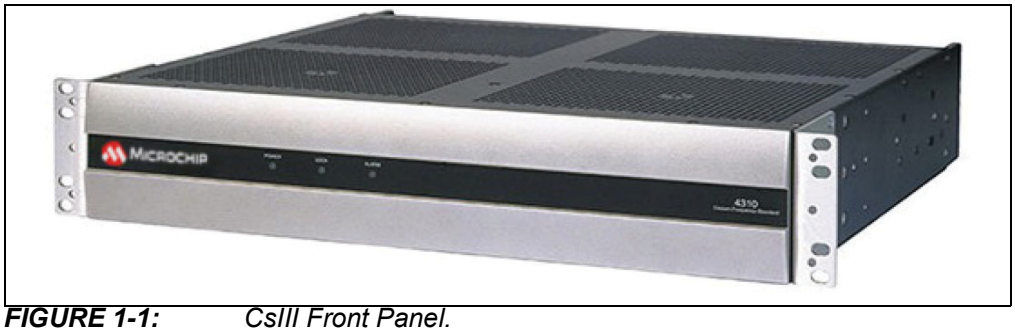


FIGURE 1-1: *CsIII Front Panel.*

1.3 REAR PANEL CONNECTIONS

- 5 MHz - BNC 5 MHz output (50Ω)
- 10 MHz - BNC 10 MHz output (50Ω)
- 10 MHz TTL - BNC 10 MHz TTL output (50Ω)
- 1PPS - BNC 1PPS output (50 Ω)
- SYNC - BNC input to synchronize 1PPS output to external source (50Ω)
- ALARM - DB9 Female, Form C relay
- RS-232 - DB9 Male DTE

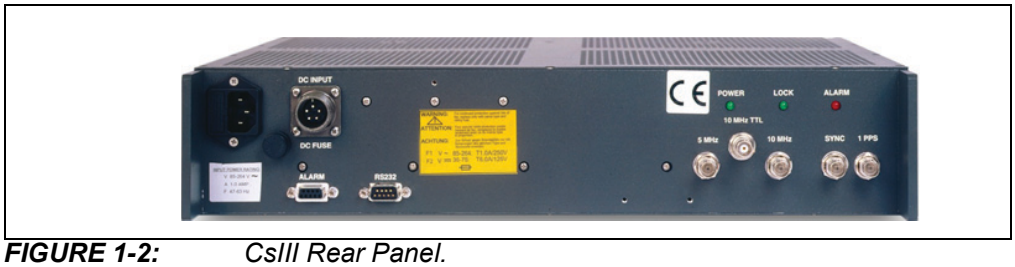


FIGURE 1-2: *CsIII Rear Panel.*

© 2021 Microchip Technology Inc.

1.4 SOFTWARE

The CsIII's principal user interface is the Microchip Monitor3 software. Monitor3 runs on Microsoft Windows PCs (Windows 95 or newer) and connects to the CsIII with a standard RS-232 null modem cable. In addition to providing comprehensive configuration and control of the CsIII, 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 trouble-shooting purposes. Monitor3 is not essential to operate the CsIII 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 CsIII. For more information about the RS-232 command structure and command list, see **Appendix B. "Programmer's Guide"**.

1.5 POWER

External power is supplied by a standard AC power cord or by a DC power connection. The following is the power hierarchy.

- The unit operates from the AC power, if AC power is available.
- The unit operates from the DC input, If DC power is available and AC power is not.

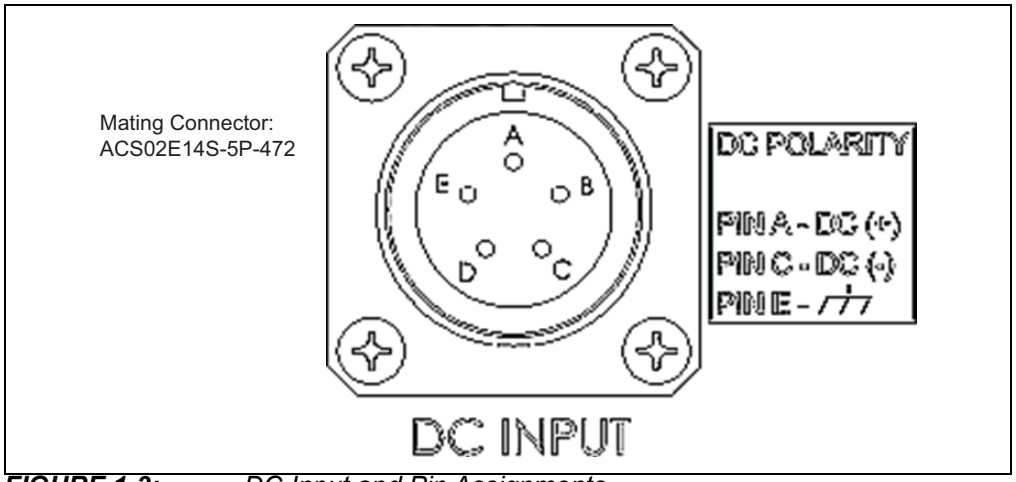


FIGURE 1-3: *DC Input and Pin Assignments.*

1.6 FACTORY CONFIGURATIONS

The CsIII is available with optional features that permit the system designer to specify the most cost- effective solution for a particular application. Optional features include:

- E1 or T1 telecommunication outputs

For complete list of options, see **Appendix A. "Specifications"**.

© 2021 Microchip Technology Inc.

Chapter 2. Installation

2.1 INSTALLATION

This section provides unpacking instructions and installation procedures for the CsIII as well as warnings, cautions, notes, and recommendations that pertain to the procedures. If you encounter problems during any of the following procedures, contact Technical Support (see **Appendix C. "Customer Assistance/Technical Support"**).

2.2 UNPACKING INSTRUCTIONS

CAUTION

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

1. Inspect the container for signs of damage. If the container appears to be damaged, notify both the carrier and the Microchip 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 matches the information on the equipment. The item number can be found on a label affixed to the rear panel. Contact the Microchip distributor if the model or item numbers do not match.

CAUTION

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

2.3 ENVIRONMENTAL CONSIDERATIONS

When installing the instrument, consider the standard environmental factors (temperature, humidity, vibration, and so on) and the presence of magnetic fields that might affect the accuracy of the CsIII. 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.

2.4 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 2U CsIII as well as an additional 1U of space above and below the CsIII
- Chassis rack supports or slides are available to support the CsIII

© 2021 Microchip Technology Inc.

2.5 TOOLS AND MATERIALS

The following is a list of recommended tools and materials (not supplied):

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

2.6 INSTALLING THE CSIII

The CsIII mounts in a standard 19-inch equipment rack. The CsIII 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 3.75" (2U).

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 on the instrument's rear panel.

CAUTION

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

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

- Mount the CsIII in the desired location in the equipment rack using standard rack mount hardware. Install the proper fuse into the fuse holder marked DC fuse on the rear panel. Fuse specifications are provided on the instrument's rear panel.
- If available, apply AC power to the CsIII by installing the detachable power supply cord at the AC Input connection on the rear panel.
- Apply DC power to DC input, if available.
- Observe that the power and alarm front panel indicators are illuminated. Wait for the unit to complete its initial acquisition sequence and stabilize. This may take up

© 2021 Microchip Technology Inc.

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 the power to the instrument initiates the warm-up and automatic lock acquisition sequence. During this time, the alarm relay is activated and the signal outputs are not active.

2.7 INSTALLING THE MONITOR3 SOFTWARE

The Monitor3 software 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 CsIII.

Following are the steps to install the Monitor3 software:

1. Download the Monitor3 software from Microchip FTD support website.
2. Install the application by running the setup.exe file.

By default, the Monitor3 application is installed in 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 2-1: RS-233 PORT DB9 TO DB25 CONNECTOR PIN-OUT

DB9-M	DB25-F	Function
3	3	Rx Data
2	2	Tx Data
5	7	Signal GND

For DB9 connector, see the following table for connector pin-out information.

TABLE 2-2: RS-232 PORT DB9 TO DB9 CONNECTOR PIN-OUT

DB9-M	DB9-F	Function
3	2	Rx Data
2	3	Tx Data
5	5	Signal GND

2.8 ESTABLISHING COMMUNICATIONS

Connect the serial port of the computer to the RS-232 port of the CsIII using a standard RS-232 null modem cable. Click Start, select Programs > Symmetricom > Monitor3. The Monitor3 interface appears as shown in Figure 3-1.

The following are the default RS-232 settings of CsIII.

- BAUD = 9600
- Data bits = 7
- Parity = Odd
- Stop bits = 2

To reconfigure these settings on the CsIII, see **Appendix B. “Programmer’s Guide”**. By default, Monitor3 initially attempts to connect to the instrument using the above parameters and PC serial port COM1. To check or adjust these communication parameters, select Configure Serial Port from the File menu. The panel shown in Figure 2-1 appears. Use this panel to adjust the Monitor3 serial communications parameters to agree with the setting of the CsIII instrument.

© 2021 Microchip Technology Inc.

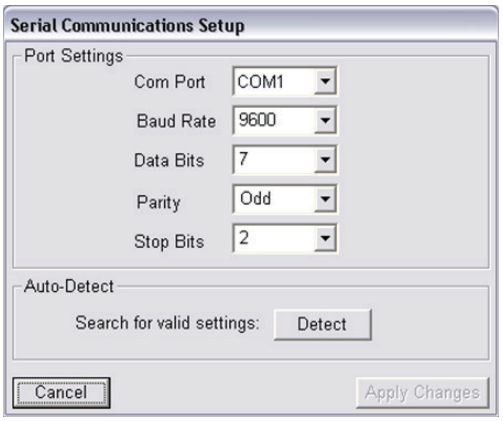


FIGURE 2-1: *Serial Communication Setup.*

The modified settings are applied when the Apply Changes button is depressed, at that time Monitor3 resets the serial port and attempts to re-establish communication with the Cesium instrument. After communication has been successfully established, the communication parameters of the CsIII can be modified, see **Appendix B. "Programmer's Guide"**.

In the event of communication problems, the Detect button may be employed to sequentially test the interface at a variety of communication parameters and locate the instrument.

By default, Monitor3 interrogates the CsIII and updates the screen information every ten seconds. The status bar, in the lower left of the main window, that reports count-down to the next update and communication activity as it occurs, indicates RS-232 status. In the event of communication failure, the status bar indicates "Unit Not Responding". In that case, Monitor3 periodically reinitializes the communication port and attempt to establish communication.

When communication has been successfully established, the Monitor3 interface appears as shown in Figure 3-1. The title bar of the Monitor3 application window reflects the instrument type (here, CsIII), the serial number (here 6172), and the PC RS-232 interface (here, COM2). Instrument state is indicated in the lower right status bar (here, Operating). By default, the displayed data updates every 10 seconds. The RS-232 status bar, on the lower left, indicates countdown to the next update and RS-232 activity as it occurs.

© 2021 Microchip Technology Inc.

Chapter 3. Operation

Prior to performing any of the operations described in this section, ensure that the installation procedures described in **Chapter 2. "Installation"** have been performed and that communication has been established between the CsIII and the Monitor3 application software.

In some installations, users may develop custom application software to provide remote control and monitoring capability. For more information about command syntax and complete command reference, see **Appendix B. "Programmer's Guide"**.

3.1 MONITOR3 MAIN STATUS WINDOW

The Figure 3-1 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 communication port. The status bar at the bottom of the main window indicates RS-232 communication activity on the left and instrument status (Warming Up, Operating, Minor Fault, or Major Fault) on the right.

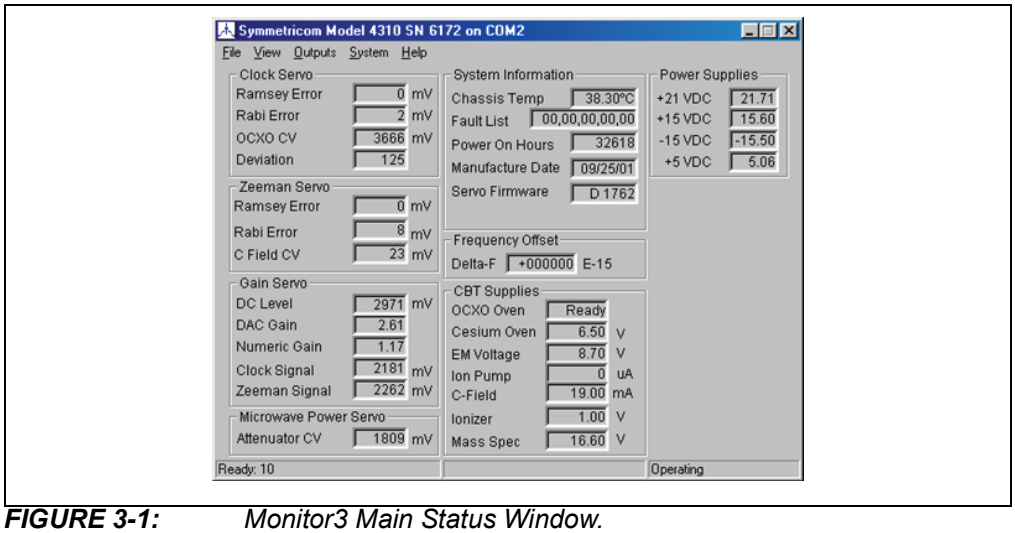


FIGURE 3-1: *Monitor3 Main Status Window.*

The body of the main window displays operating and configuration data for the CsIII instrument. The main window updates periodically (see **Section 3.2 "Unit Monitoring and Data Logging"**). 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 Cesium Beam Tube Power Supplies monitors. The right hand column displays monitors of the internal Power Supplies. The definitions, interpretation, and normal values of the displayed data are discussed in the following sections and **Appendix B. "Programmer's Guide"**.

© 2021 Microchip Technology Inc.

3.2 UNIT MONITORING AND DATA LOGGING

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

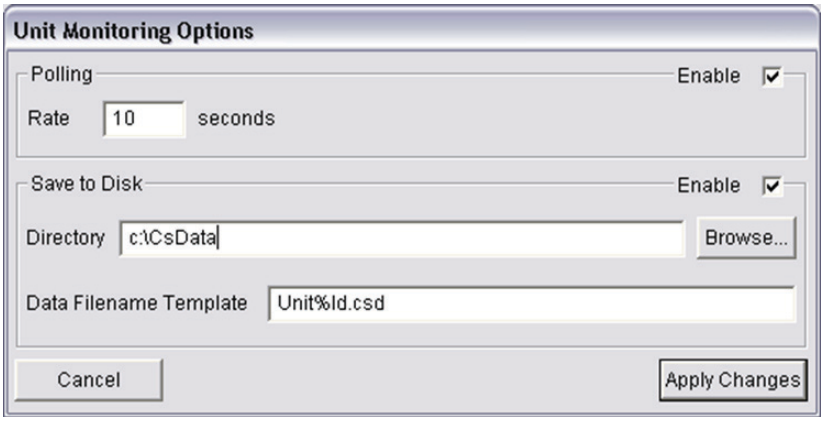


FIGURE 3-2: *Unit Monitoring Options.*

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

To save the monitor data to the PC's hard disk for archive or subsequent analysis, enable the Save to Disk check box. The data is saved at each polling interval in the directory specified. The output directory can be changed either by typing a new directory name into the directory field or by activating the Browse... panel and selecting a new directory from the tree displayed therein. Note that the data is not 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 %Id is replaced with the serial number of the CsIII instrument when the file is created. In this example, the saved data would appear in the file: c:\Unit6172_-Data.csv.

The saved data file contains 38 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 3-1. Note that the values displayed in the "Typical" column correspond to those in Figure 3-1.

TABLE 3-1: INTERPRETATION OF COLUMNS IN THE DATA FILE CREATED BY UNIT MONITORING

Column	Heading	Description	Typical	Range	Units
1	MJD	Fractional days since 0hr November 17, 1858. Measured by PC clock	52991.8122 days	—	Days
2	ID	Serial number of unit	6172	0-99999	—
3	Unit Type	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	—

© 2021 Microchip Technology Inc.

TABLE 3-1: INTERPRETATION OF COLUMNS IN THE DATA FILE CREATED BY UNIT MONITORING (CONTINUED)

Column	Heading	Description	Typical	Range	Units
6	Alarm 1	First element of prevailing alarm list	00	00 - FF	—
7	Alarm 2	Second element of prevailing alarm list	00	00 - FF	—
8	Alarm 3	Third element of prevailing alarm list	00	00 - FF	—
9	Alarm 4	Fourth element of prevailing alarm list	00	00 - FF	—
10	Alarm 5	Fifth element of prevailing alarm list	00	00 - FF	—
11	StdDev	Signal Standard Deviation	0	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	17-21	mV
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	mV
24	NumGain	Numerical Gain	1.17	0.1-9999	—
25	TChasis	Chassis Temperature	38.3	0-99	°C
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	—	±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
35	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	—	—

3.3 ADJUSTING OUTPUT FREQUENCIES

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

Note: Unless noted otherwise, all references to frequency refer to fractional frequency (Hz/Hz) and not absolute frequency (Hz).

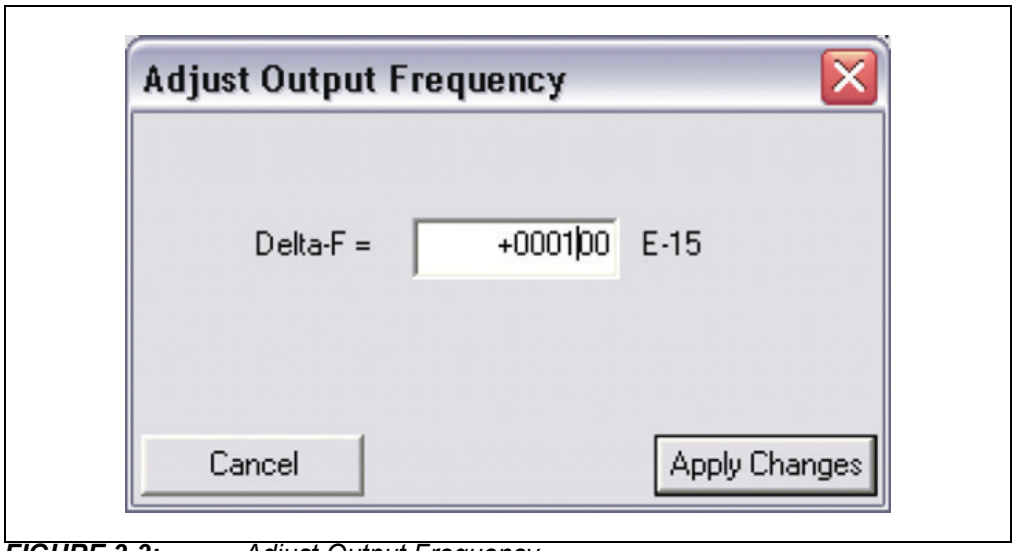


FIGURE 3-3: *Adjust Output Frequency.*

The Adjust Output Frequency panel appears, as shown Figure 3-3, reflecting the current programmed offset of the CsIII, 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 Apply Changes to upload the correction to the CsIII. To exit the Adjust Output Frequency panel without applying changes, select Cancel. The updated output adjustment is reflected in the Frequency Offset field following the next RS-232 update of the displayed data.

3.4 SYNCHRONIZING TO A 1 PPS SOURCE

The 1 PPS output of the CsIII 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. To synchronize the 1 PPS output to an external user-supplied 1 PPS source, with 100 nS resolution, connect the 1PPS source to the back-panel 1 PPS Sync input and select Synchronize 1 PPS to External Source from the Outputs menu. The panel appears as shown in Figure 3-4.

© 2021 Microchip Technology Inc.

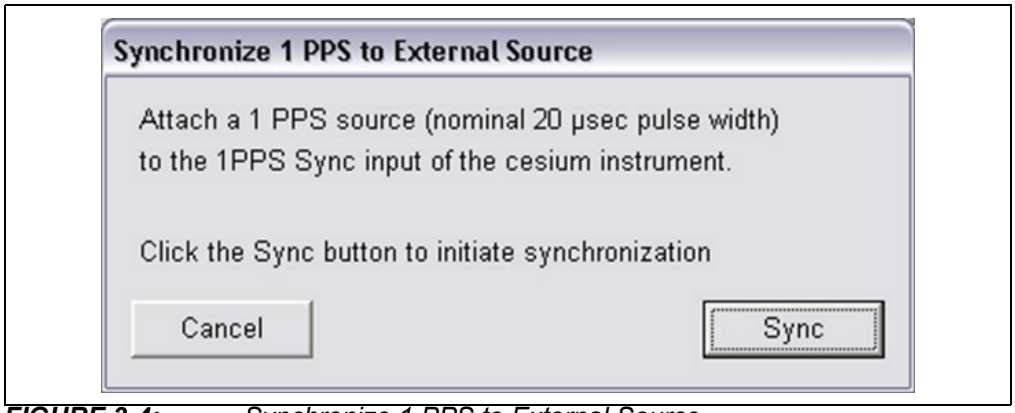


FIGURE 3-4: *Synchronize 1 PPS to External Source.*

The CsIII synchronizes its 1PPS outputs to within ±100 ns of the applied external 1PPS source if a rising edge is detected within three seconds after pressing the Sync button. Select Cancel to exit the panel without re-synchronizing the 1 PPS output.

3.5 SLEWING THE OUTPUT PHASE

To provide finer resolution adjustment of the output phase that 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 CsIII by either $\bar{y} = 1 \times 10^{-9}$ or $\bar{y} = -1 \times 10^{-9}$ or N seconds, thereby introducing a phase offset of plus or minus N ns, respectively. Note that, unlike the 1PPS synchronization feature, the Delta-T function affects the phase on all outputs, including RF and 1PPS.

Note 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, introduces a $\bar{y} = 1 \times 10^{-9}$ error in all clock outputs, persisting for 1,000,000 seconds, almost 12 days. To avoid introducing an offset for such a long duration, it is recommended to use the Sync 1PPS feature to bring the phase to within 100 ns of the desired value.

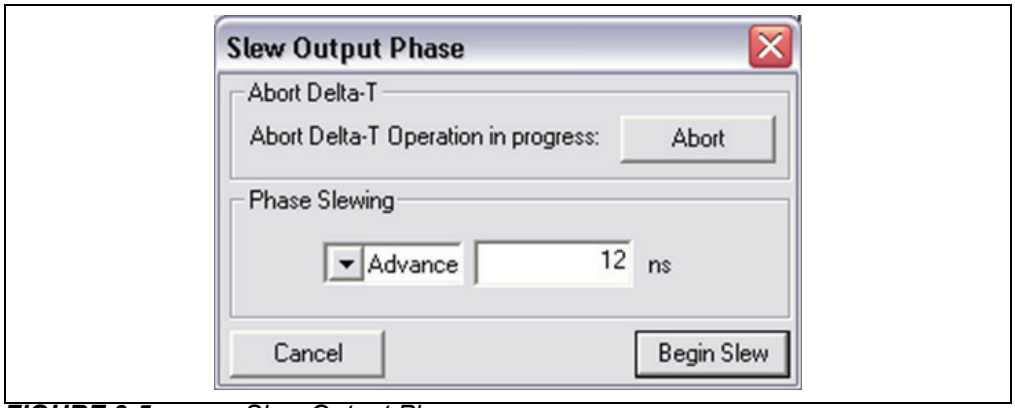


FIGURE 3-5: *Slew Output Phase.*

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, in the range of 0- ns 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 CsIII is immediately offset by either $\bar{y} = 1 \times 10^{-9}$ or $\bar{y} = -1 \times 10^{-9}$, depending on whether Advance or Retard is selected, respectively. 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.

© 2021 Microchip Technology Inc.

3.6 ALARMS

The CsIII microprocessor system 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 the parameters deviate from its acceptable value.

Alarms 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 causes 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 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 **View** menu.

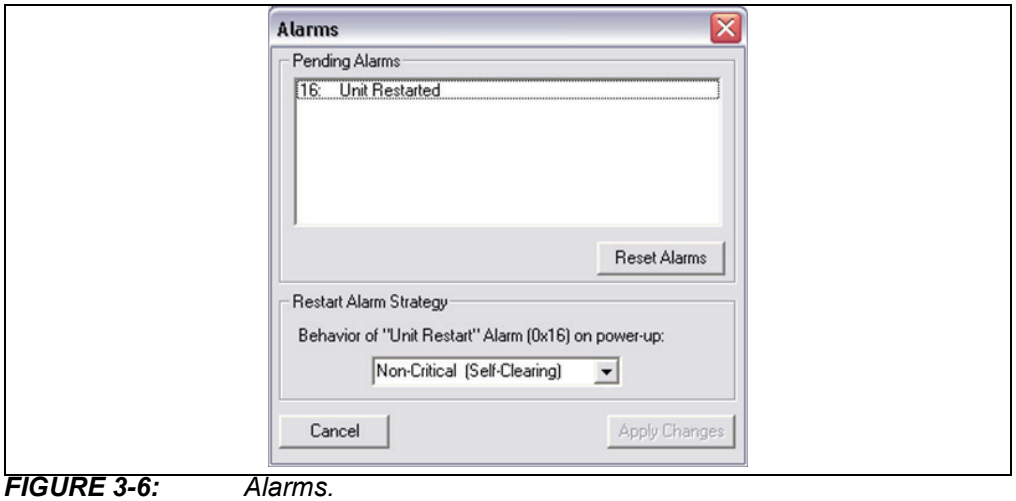


FIGURE 3-6: *Alarms.*

The Alarms panel, shown above, enumerates all alarms currently present in the system. To clear standing alarms, press the Reset Alarms button. The list of pending alarms is updated at the next regular polling interval. For a complete list of possible alarms, see **Chapter 4. "Maintenance and Troubleshooting"**.

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 CsIII 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 reacquisition and remain muted thereafter until the user clears the 0x16 alarm flag.

© 2021 Microchip Technology Inc.

3.7 EVENT LOGGING

The CsIII maintains a log of alarm indicators, including major and minor alarms and unit restart events. The Event Log is maintained in battery-backed non-volatile memory 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 and 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.

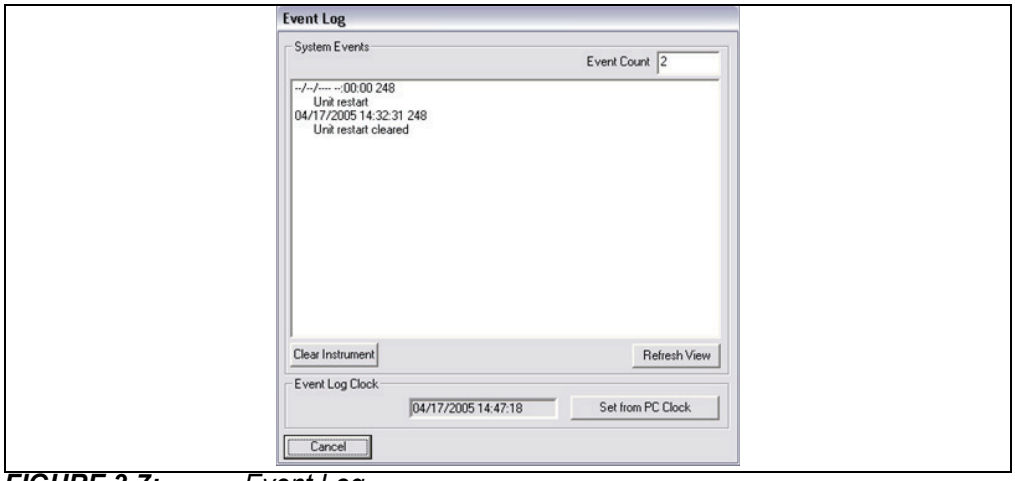


FIGURE 3-7: *Event Log.*

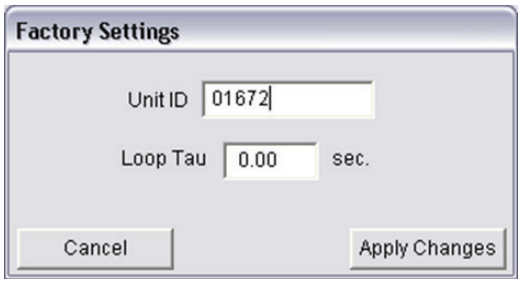
The Event Log is downloaded from the instrument when the Event Log panel is loaded or when the user clicks Refresh View. Note that downloading the Event Log from the CsIII can take up to several minutes, depending on the number of events and the connection speed. Because of this necessary delay, the 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 CsIII 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. After 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.

The non-volatile Event Log storage contains 128 events. After 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 nonvolatile Event Log, press the Clear Instrument button. In permanent installations, Microchip recommends clearing the Event Log and setting the Event Log Clock upon installation.

3.8 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.



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 and this value should not be changed, except by an expert. 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.

3.9 COMMUNICATIONS

Upon delivery, the CsIII 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 CsIII instrument may be adjusted from the RS-232 panel on the System menu.

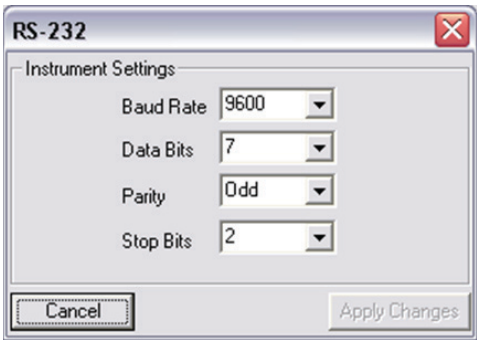


FIGURE 3-8: *RS-232.*

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

© 2021 Microchip Technology Inc.

Chapter 4. Maintenance and 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, see contact listed in **Appendix C. "Customer Assistance/Technical Support"**.

Note: Save the instrument's original packing materials for re-shipping the product. If these are not available, contact Technical Support for a replacement.

4.1 PREVENTIVE MAINTENANCE

The CsIII 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. To clean the device, wipe the exterior chassis using a soft cloth dampened with mild soapy water.

The following table lists suggested preventive maintenance measures to be performed 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 4-1: 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 Microchip Technical Support See **Appendix C. "Customer Assistance/Technical Support"**.
Case screws	Inspect for loose or missing screws or hardware on shelf.	If loose, tighten securely. Replace missing hardware.

© 2021 Microchip Technology Inc.

If the alarm activates and the ALARM LED remains lit indicating a failure of the CsIII, call Microchip Customer Service for instructions. Table 5-2 lists the two digit hexadecimal fault codes along with their description. Prior to calling Customer Service, 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 section **Section 3.6 "Alarms"**.

4.2 SHIPPING

To turn off the Microchip CsIII 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.

4.3 HAZARDOUS MATERIAL (HAZMAT) SHIPPING CONSIDERATIONS

Microchip 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, Cesium is classified as a hazardous material by the U.S. Department of Transportation (USDOT) and the International Air Transport Association (IATA). During normal handling the Microchip CsIII 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 and its labeling.

The initial shipment of every Microchip 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

4.4 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 section **Section 4.5 "Shipping Carriers"**. 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, contact customer support. See contact listed in **Appendix C. "Customer Assistance/Technical Support"**.

© 2021 Microchip Technology Inc.

4.5 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. The following figure 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.

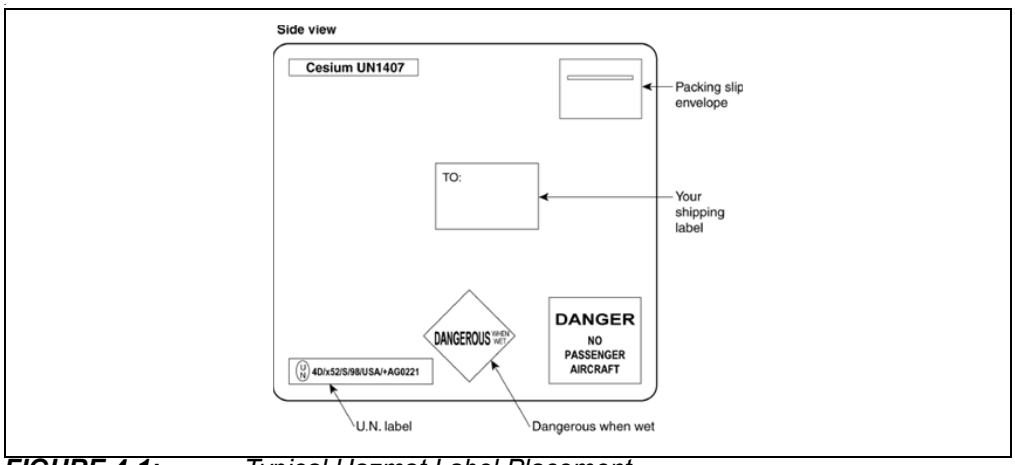


FIGURE 4-1: *Typical Hazmat Label Placement.*

Several United States and international shipping companies can accommodate properly packaged hazardous materials. United Parcel Service and Federal Express are examples for the United States. Intercontinental (617-569-4400) provides international shipping services. Contact one of these shipping companies for assistance. If you need additional help, contact customer support. See contact listed in **Appendix C. "Customer Assistance/Technical Support"**.

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

4.6 STORAGE

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

4.7 CESIUM BEAM TUBE VACUUM

If the CsIII 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 CsIII must be turned-on and operated for a minimum of 30 minutes on or before the first six month storage interval.

4.8 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.

NOTES:

© 2021 Microchip Technology Inc.

Chapter 5. Theory of Operation

This section provides the theory of operation of the CsIII Cesium beam frequency standard. It is intended to supplement the functional description provided in earlier chapters and provide a more complete understanding of instrument operation.

5.1 CESIUM BEAM FREQUENCY STANDARD CONCEPT

As described in **Chapter 1. "Product Overview"** 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 5-1 shows a conceptual diagram of the CsIII.

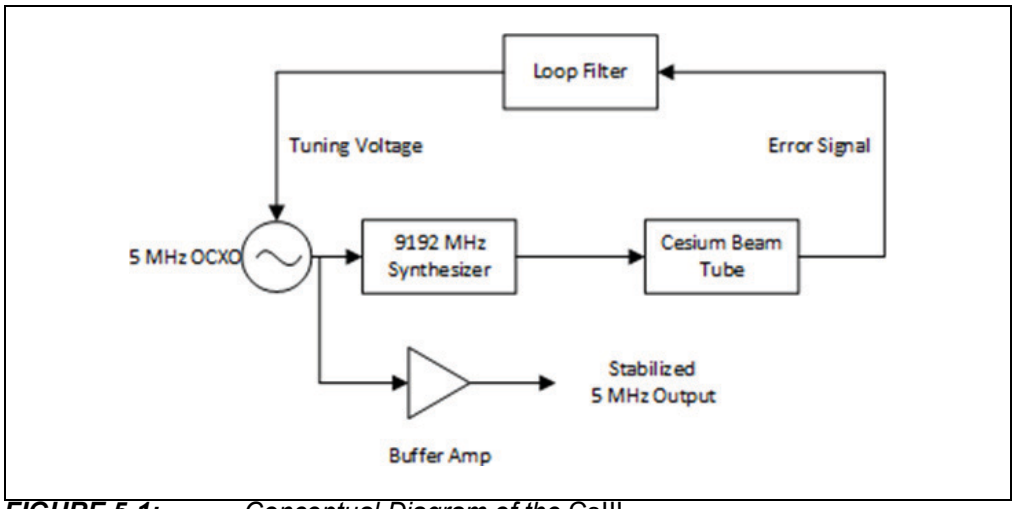


FIGURE 5-1: *Conceptual Diagram of the* CsIII.

The fundamental accuracy and stability of the CsIII 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 CsIII 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, that is typically on the order of $\tau = 1$ second, the

© 2021 Microchip Technology Inc.

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.

The following Figure 5-2 shows a block diagram of the CsIII.

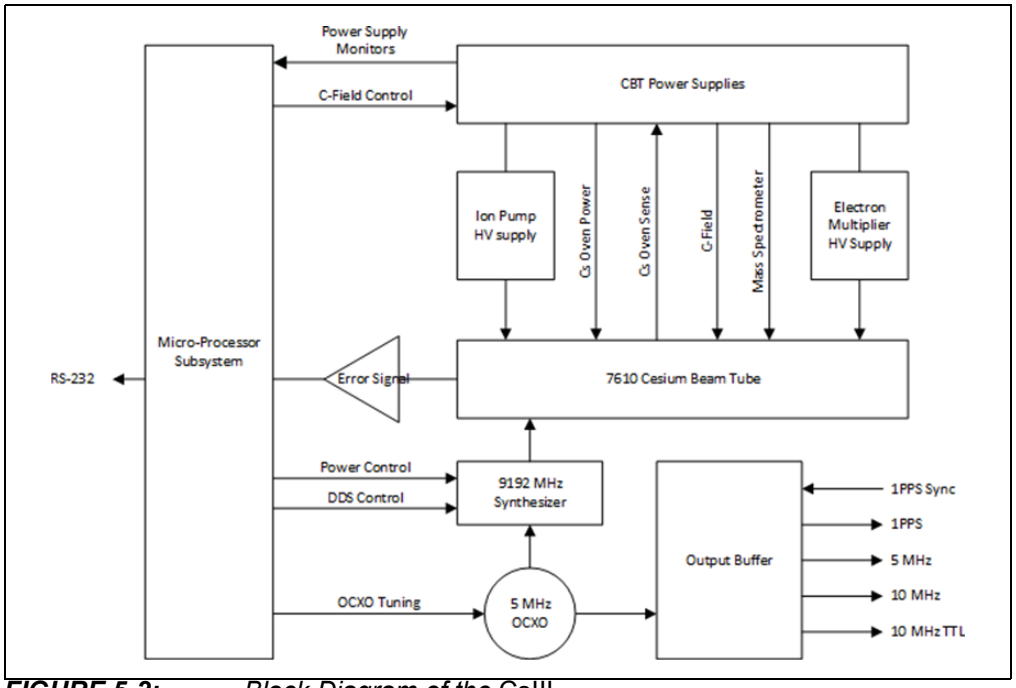


FIGURE 5-2: *Block Diagram of the* CsIII.

The principal components of the CsIII 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, that 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.
- Cesium beam tube and other secondary power supplies.

5.2 CESIUM BEAM TUBE

The heart of the instrument is the Microchip 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 5-3.

© 2021 Microchip Technology Inc.

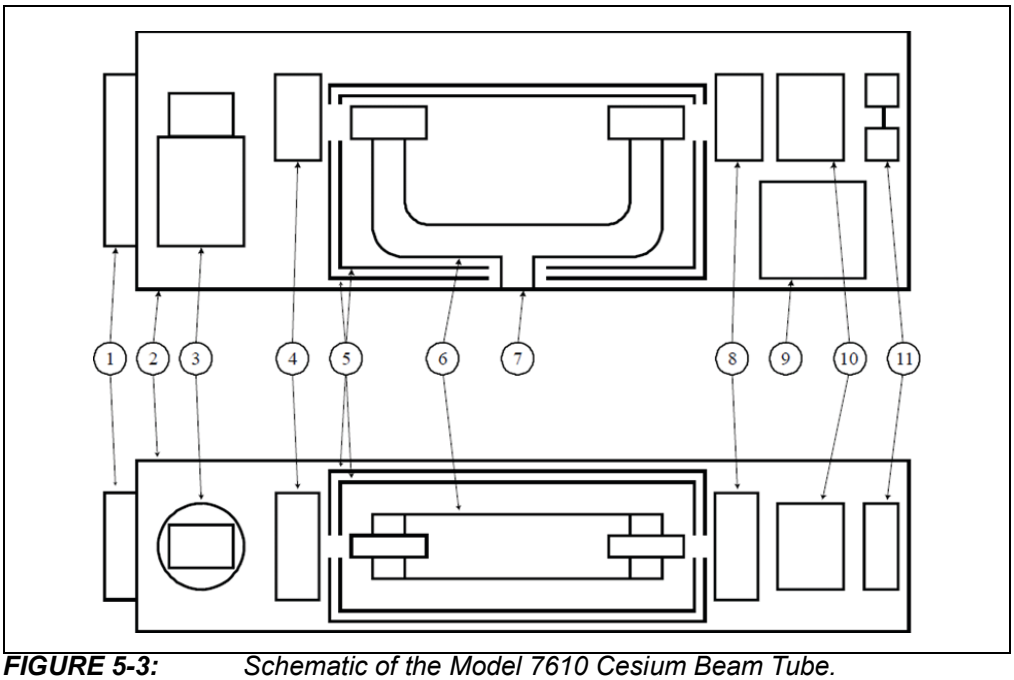


FIGURE 5-3: *Schematic of the Model 7610 Cesium Beam Tube.*

The Key is as follows:

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 the following

© 2021 Microchip Technology Inc.

resonance examples). 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 direct 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 nano amperes, is converted to a voltage by a low- noise trans-impedance 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 CsIII, 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 ± S, that is 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 mF, where mF takes on the integer values from –F to +F. The behavior of the Cesium ground state sub levels in an applied magnetic field is shown in Figure 5-4.

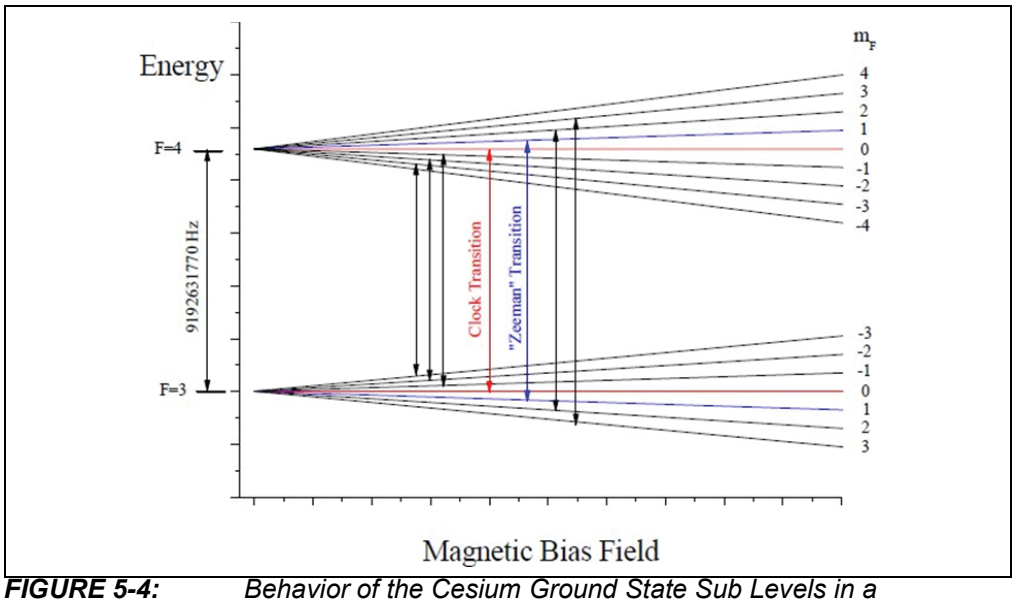


FIGURE 5-4: *Behavior of the Cesium Ground State Sub Levels in a Magnetic Field.*

With the exception of the mF = 0 sub levels, all of the energy sub levels exhibit a linear dependence on the applied magnetic field of approximately 350 kHz/Gauss. For this reason, the Cesium beam frequency standard operates on the F = 3, mF = 0→ F = 4, mF = 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 sub levels, that is Δm F = 0. There are, thus, seven possible transitions between the F = 3 and F = 4 ground states, as shown in Figure 5-4 . 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

© 2021 Microchip Technology Inc.

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 $\Delta m_F = 0$ transitions is shown in the following figure, as the RF frequency is swept across 400 kHz around 9192631770 Hz.

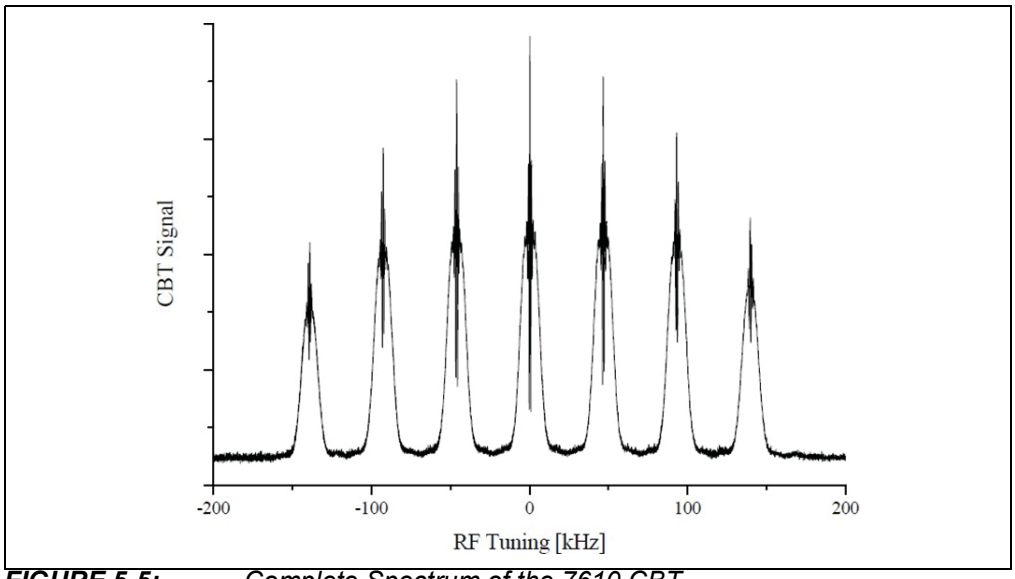


FIGURE 5-5: *Complete Spectrum of the 7610 CBT.*

The complete 7610 CBT spectrum includes all seven allowed Δm = 0 magnetic dipole transitions between the Zeeman sub levels 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, in this case 46.4 kHz. The clock transition, that 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 in Figure 5-6.

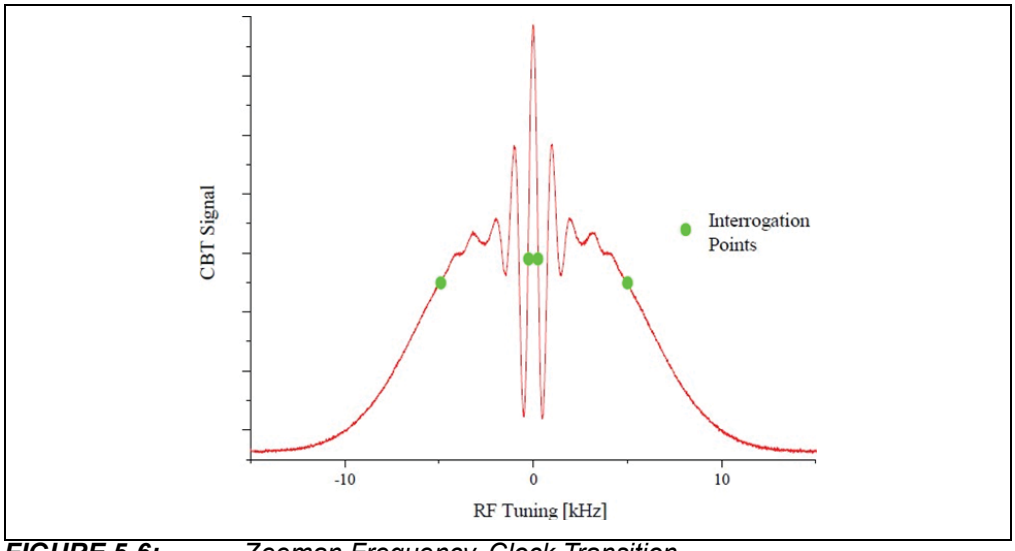


FIGURE 5-6: *Zeeman Frequency, Clock Transition.*

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 line width reflects the travel time through one of the two regions.

5.3 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, v_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 $v = v_C \pm 250$ Hz. The Ramsey error signal is the voltage difference (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 $\tau = 1$ 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 mV - 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 $v = v_C \pm 5000$ Hz. The Clock Servo Rabi error is continuously averaged by the microprocessor with a 100 second time constant. So far 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 × 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 CsIII instrument. Typically, upon delivery, the OCXO control voltage is between 2 VDC 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 $\sigma_y(\tau) \alpha \tau^{-1/2}$. and thus, properly scaled, the signal deviation parameter is proportional to the 1-second Allan deviation of the CsIII 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. A standard performance CsIII 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 CsIII adaptive clock servo algorithm as a measure of signal quality. If the CsIII 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

© 2021 Microchip Technology Inc.

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).

5.4 ZEEMAN SERVO

It is necessary to apply a magnetic bias field (the C-Field) to the RF interrogation region 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:

EQUATION 5-1:

$$V_C = V_0 + (8/V_0) \times \delta V_Z^2$$

Where:
v_0 = The unperturbed clock frequency (v_0 = 9192631770 Hz)
δv_Z = The Zeeman frequency

The Zeeman Frequency δv_Z is defined to be the splitting between adjacent hyperfine transitions and which varies linearly with the applied C-field. In the CsIII, the Zeeman frequency, δv_Z = 46,379.831 Hz, leading to a corrected clock frequency of v_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 30ppm in order to guarantee long-term stability of the CsIII at the level of 1 part in 10^{14}.

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, that is at $v = v_C + \delta v_Z \pm 250$ 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, that 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, that is measured at $v = v_C + \delta v_Z \pm 5000$ 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 1012. In this case, a major alarm (0x02) is declared and the CsIII attempts to reacquire the Zeeman servo. Monitor3 also reports the C-Field control voltage, that 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 mA and 19.5 mA. If the C-Field current falls below 16 mA or rises above 22 mA, a major alarm (0x05) is declared.

5.5 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 as follows:

- Guarantee that the resolution of the ADC is fully utilized
- Present consistent signal levels to the clock servo, and 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.

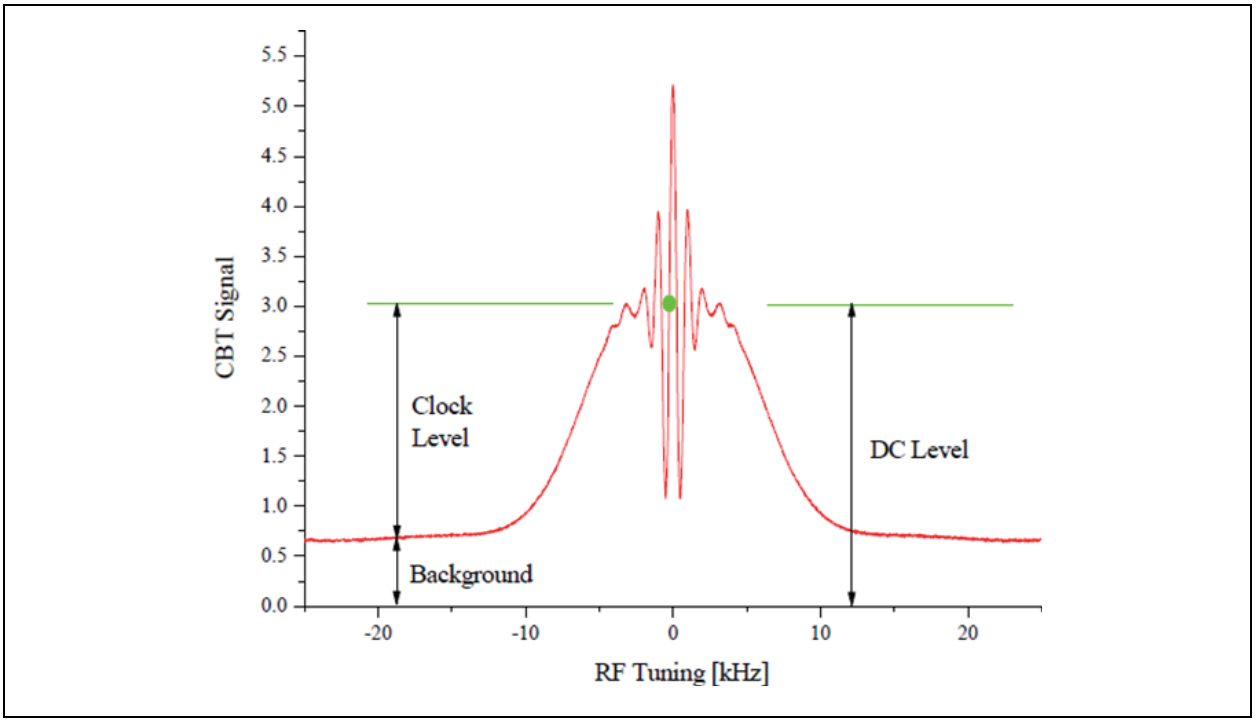


FIGURE 5-7: *CBT Signal and RF Tuning.*

The function of the DAC gain is to amplify the DC Level, measured at the clock Ramsey interrogation points, to approximately 3 volts, 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 CsIII 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.

5.6 MICROWAVE POWER SERVO

The short-term stability, accuracy, and environmental sensitivity of the CsIII 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 5-8 shows the microwave power dependence of the 7610 CBT signal, measured at the clock Ramsey interrogation point as the output.

© 2021 Microchip Technology Inc.

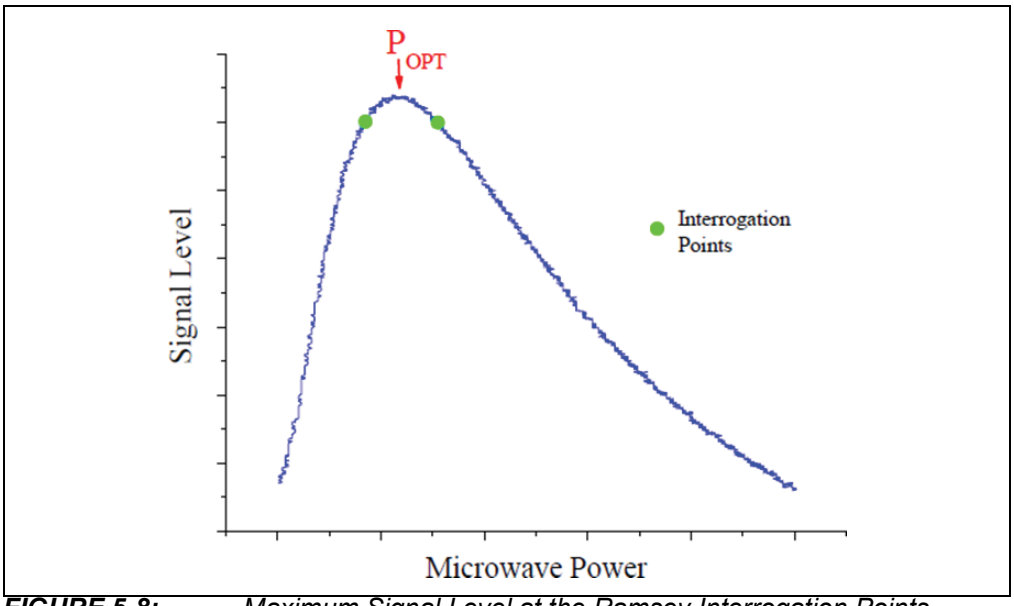


FIGURE 5-8: *Maximum Signal Level at the Ramsey Interrogation Points.*

The optimum microwave power point, designated POPT is indicated in the above figure. To ensure that the microwave power is always optimized, the CsIII 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 0V - 5V and the synthesizer is set in the factory such that POPT is accomplished near to a setting of 2.5V. In normal operation the Microwave Power Control Voltage may vary from 1.5V to 4V, particularly in response to changes in ambient temperature.

5.7 UNIT INITIALIZATION

Upon power-up, the CsIII performs the following sequence of operations.

TABLE 5-1: WARM-UP SEQUENCE

Warm-up Sequence	Completion Indicator
Firmware and non-volatile RAM consistency check	RS-232 communication begins
OCXO Oven Warm-up	OCXO Oven changes from “cold” to “Ready”
Cesium Oven Warm-up	Cesium Oven voltage drops below 10V
Clock Rabi Acquisition	Clock Rabi Error <40 mV
Clock Ramsey Acquisition	Clock Ramsey Error <40 mV
Gain Servo Initialization	Clock Level >2000 mV
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.

© 2021 Microchip Technology Inc.

5.8 ALARMS AND INDICATORS

In addition to the system monitors relating to servos and Cesium beam tube parameters, 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 the following table.

TABLE 5-2: 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/Major
0x08	VCXO tuning voltage	<10% or >90% of range	Minor
0x09	Ambient temp	>80°C	Major
0x12	5V supply	<4.75 V or >5.25 V	Major
0x13	Positive 15V supply	<13.75V or >17.0 V	Major
0x14	Negative 15V supply	<–13.75V or >–17.0 V	Major
0x16	Unit restart	Set on reboot	Minor/Major
0x17	Module configuration	Checksum failure on reboot	Informative only
0x18	DAC gain at maximum	=256	Minor
80	Software failure	—	Major
81	Event log invalid	Checksum failure on reboot	Informative only
0xF1	Cesium oven voltage	>10.0 V (after Cs lock)	Major
0xF2	Oscillator oven warm-up	Unlock (after Cs lock)	Major
0xF3	Ionizer voltage	>±160 mV off factory setting	Major
0xF4	Ion pump current	>175 µA	Major
0xF5	21V power supply	<17V or >24V	Major

© 2021 Microchip Technology Inc.

Appendix A. Specifications

For latest product specifications, see product data sheet DS00003499.

A.1 ALARM INTERFACE

The main advantage of employing CPT is it allows the use of low power lasers allowing to construct low power, small size atomic clocks.Alarm (relay): DB9 female (Rear panel).

The following table lists the alarm connector pin-out configuration.

TABLE A-1: ALARM CONNECTOR PIN-OUT CONFIGURATION

Connector Type	Pin Number	Function
DB9-F (J5)	1	+12V Output (180 mA)
	2	+12V Return
	3	N/C
	4	Major (Common)
	5	Major (Fault = Closed)
	6	Major (Fault = Open)
	7	N/C
	8	N/C
	9	N/C

A.2 OPTIONS

- Portability kit: Includes handle and rubber feet (p/n 14959-101)
- DS1: Dual 1544 kbps outputs. 1 balanced, 1 unbalanced (p/n 13945-102)
- DS1-B: Dual 1544 kbps outputs. Bantam connectors (p/n 13945-103)
- E1: Dual 2048 kbps (G.703/6) outputs plus 2.048 MHz (G.703/10) (p/n 13945-101)

© 2021 Microchip Technology Inc.

NOTES:

© 2021 Microchip Technology Inc.

Appendix B. 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 and the command list. Note that this section is designed for experienced programmers and assumes a general knowledge of RS-232 interface programming.

B.1 GENERAL PARAMETERS

The CsIII's factory-default RS-232 settings, modifiable using the C05 command, are as follows:

- Configuration: DTE
- Data Bits: 7
- Parity: None
- Stop Bits: 2
- Baud Rate: 9600

B.2 RESTART MESSAGE

Upon restart the DCC transmits the following message to the RS-232 Port.

<STX>Symmetricom_CsIII:_system_start<ETX>

TABLE B-1: RESTART MESSAGE DESCRIPTION

Element	Description
<STX> ASCII	0x02
_	Space character
<ETX> ASCII	0x03

B.3 CESIUM COMMAND REFERENCE

Commands are sent to the CsIII over the RS-232 port. The command set is backwards compatible with Microchip instruments based on the 4201A/5045 architecture (4040, 4065). Several new commands support the new capabilities of the CsIII. General format is as follows:

<STX>_<Function Code>_<IDENT>_<DATA><ETX>

TABLE B-2: CESIUM COMMAND REFERENCE DESCRIPTION

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 CsIII return a response of the form

<STX><Text of response><ETX>

Table B-3 lists all commands recognized by the CsIII.

If the CsIII receives a malformed or non-compliant command or if the command addresses an optional feature that is not currently installed (that is commands which address features particular to other Microchip Cesium instruments), the CsIII 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 data field)

CsIII Response:

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

The following table defines the CsIII 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 CsIII instrument. Issuance of commands labeled Reserved for Factory Use may render the CsIII inoperable and void the warranty.

© 2021 Microchip Technology Inc.

TABLE B-3: CSIII COMMAND REFERENCE

CMD	Description	Data Field
W00	Reset alarms	No data required
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
W02	Reserved for Factory Use	—
W03	Phase offset (advance or retard 10 MHz phase by N ns)	Sign plus 4 digits
W04	Halt phase offset operation	No data required
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 1PPS Sync circuit. Issue this command after connecting a 1PPS source to the CsIII. The sync remains armed for 3 seconds	No data required
D*1	Return variables (250 characters)	No data required
D*2	Return constants (145 characters)	—
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
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	—
A01	Reserved for factory use	—
A02	Reserved for factory use	—
A03	Reserved for factory use	—

© 2021 Microchip Technology Inc.

TABLE B-3: CSIII COMMAND REFERENCE

CMD	Description	Data Field
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 and 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
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	—

Note: "W00" clears all pending alarms. The return value is an echo of the received command. "C05" sets the serial port parameters to new settings.
For example:

```
<STX>C05_00000_19200,8,N,1<ETX>
```

The return value would be similar to the following:

```
Setting Serial Parameters to XXXX, 8,N,1
```

Where XXXX is new baud rate setting.

© 2021 Microchip Technology Inc.

TABLE B-4: 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	—	—
+21 VDC 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	175 - 180	T+27.7
Space 181	—	—
+15.5 V power supply	182 - 187	+15.1V
Space 188	—	—
–15.5 V power supply	189 - 194	–16.2V
Quartz oscillator cold/warm	196 - 198	Olc
Space 199	—	—
Cesium oven supply voltage	200 - 205	F008.0

TABLE B-4: DATA RETURNED BY THE "RETURN VARIABLES" COMMAND D*1 (CONTINUED)

Variable	Field	Example
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 B-5: DATA RETURNED BY THE "RETURN CONSTANTS" COMMAND D*2

Variable	Field	Example
STX CR LF	1 - 3	—
Space 11	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	—	—

© 2021 Microchip Technology Inc.

TABLE B-5: DATA RETURNED BY THE "RETURN CONSTANTS" COMMAND D*2

Variable	Field	Example
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	—

B.4 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 CsIII lacks a battery backed up real time clock, the Event log stores two distinct timestamps. The first is a 6 byte calendar date; the second is a 32-bit value representing the total system power on hours.

NOTES:

© 2021 Microchip Technology Inc.

Appendix C. Customer Assistance/Technical Support

Microchip backs its products with various support services including Customer Service, Customer Technical Support Center, a website, electronic mail, and global sales offices. This appendix contains information about contacting Microchip using these support services. Visit the support web page for the latest software and documentation: www.Microsemi.com/ftdsupport.

To access the support, login to the Microchip web page or create an account if you don't have one already: www.Microchip.com/products/timing-synchronization-systems/support/online-support.

This product contains the software with the latest version at the time of manufacture. Refer to user guides and any system release notices from the website for the latest versions of software and installation procedures: www.Microchip.com/products/timing-synchronization-systems /downloadlibrary.

For Customer Service, contact Microchip Frequency and Time division services and support at:

USA, Americas, Asia, and Pacific Rim

Microchip FTD Services and Support
3870 N, First Street
San Jose, CA 95134
Telephone: 408-428-7907

Toll-free in North America: 1-888-367-7966
email: ftd.support@Microchip.com

Europe, Middle East, and Africa (EMEA) Technical Support

Microchip FTD Services and Support EMEA Altlaufstrasse 42
Hoehenkirchen-Siegertsbrunn 85635 Germany Telephone: +49 700 3288 6435 Fax: +49 8102 8961 533

email: ftd.emeasupport@Microchip.com

EMEA Sales

email: ftd.emea_sales@Microchip.com

© 2021 Microchip Technology Inc.

NOTES:

© 2021 Microchip Technology Inc.

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880- 3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

© 2021 Microchip Technology Inc.

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP