

OPERATING MANUAL
Symmetricom 4310A
Cesium Frequency Standard

Part Number: 13894-201
Revision: E

Printed: 16 April 2003
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Symmetricom, 34 Tozer Road, Beverly, MA 01915
phone: 1-978-927-8220 fax: 1-978-927-4099

DECLARATION OF CONFORMITY

Application of Council Directive(s): **73/23/EEC**

Standard(s) to which Conformity is Declared:

EN61010-1

(EN 60950:1992, Including Amendment Nos. 1,2,3,4,11)

Manufacturer's Name **Symmetricom**

Manufacturer's Address **34 Tozer Road
Beverly, MA 01915**

Importer's Name

Importer's Address

Type of Equipment **Class I**

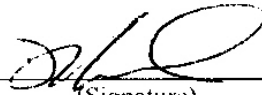
Model Number **4310A**

Serial Number **See Serial Number Label**

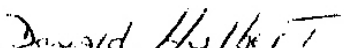
Year of Manufacture **See first two digits of Serial Number Label
(Example: 99 = 1999)**

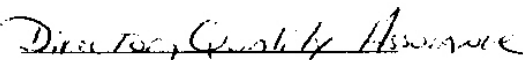
I, the undersigned, hereby declare the equipment specified above conforms to the above identified standard(s) as described in the test record.

Place **Symmetricom - Beverly**


(Signature)

Date **December 17, 2000**


(Full Name)


(Position)

CHOMERICS TEST SERVICES
77 Dragon Court
Woburn, Massachusetts 01888

CERTIFICATE OF CONFORMANCE

Date of Issue: September 12, 2000

Issued To: **Symmetricom**
34 Tozer Road
Beverly, Massachusetts 01915-5510

Reference: Chomerics Test Services Test Report Numbers EMI2636A-B.00 and SAF2636.00

Chomerics Test Services hereby acknowledges that EMC testing was performed in accordance with the standards as listed below. Chomerics Test Services further acknowledges that the test sample as described within this certificate was found to be in compliance with these standards.

This certificate is hereby issued to Datum Inc. and is valid only for the equipment and standards as described within this certificate. For further details regarding the equipment under test, reference Chomerics Test Services Test Report Numbers EMI2636A-B.00 and SAF2636.00.

Manufacturer: **Symmetricom**
Equipment Tested: 4310A Cesium Frequency Standard - CSIII

EU EMC Directive 89/336/EEC:

EN55011 Class B Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment

EN613261 (1997) Limits and methods of measurement of electrical equipment for measurement, control and laboratory use
IEC 1000-4-2 (1995) Electrostatic discharge immunity
IEC 1000-4-3 (1995) Radiated, radio-frequency, electromagnetic field immunity
IEC 1000-4-4 (1995) Electrical fast transient/burst immunity
IEC 1000-4-5 (1995) Surge Immunity
IEC 1000-4-6 (1996) Immunity to conducted disturbances, induced by radio-frequency fields
IEC 1000-4-11 (1994) Voltage dips, short interruptions and voltage variations immunity

IEC 1000-3-2 (1995) Limits for harmonic current emissions (equipment input current $\leq 16A$)

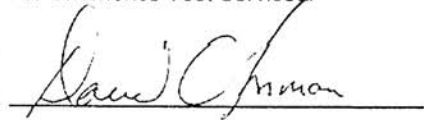
IEC 1000-3-3 (1995) Limitation of voltage fluctuations and flicker in low voltage supply systems (rated current $\leq 16A$)

Low Voltage Directive 73/23/EEC

EN61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use

For Chomerics Test Services:

Date:



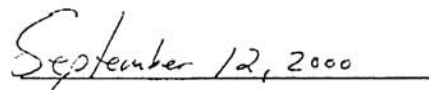


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SECTION 1. GENERAL INFORMATION

1.1 INTRODUCTION

The *Cesium Frequency Standard* compares the frequency of a stable crystal oscillator with the resonant frequency of the cesium atom. This manual contains detailed performance and installation specifications (Section 1), Operating Procedures (Section 2) and Commands (Section 3) for the *Cesium Frequency Standard*.

1.2 SUMMARY DESCRIPTION

The new **Symmetricom CsIII** represents a leap forward in terms of making Cesium Beam Frequency Standard technology available to an ever increasing base of demanding users in communications, timing, synchronization and other applications.

The **Symmetricom CsIII** is the world's smallest and most economical solution for critical applications requiring the extraordinary accuracy, stability, and independence that only cesium based instruments can provide. Housed in a 2U high, 19 inch rack mounting package, the Symmetricom Cesium III weighs only 22 pounds (10kg).

Symmetricom CsIII provides 5MHz and 10MHz RF sine wave outputs together with a 1 PPS output. In addition, the unit includes comprehensive system monitoring and control via a standard RS232 port.

Symmetricom's comprehensive product offerings provide solutions that address the need for distribution and alternative outputs. These rack mount or bench top products include units for RF frequency conversion, RF distribution, 1 PPS distribution and synthesizers to provide a range of signals.

A complete list of performance characteristics is provided in Table 1-1.

1.3 INSTRUMENT IDENTIFICATION

The instrument model name is *Symmetricom 4310A Cesium Frequency Standard—CsIII*.

TABLE 1-1 SPECIFICATIONS, *Cesium Frequency Standard* (at 25°C unless otherwise specified)**• PERFORMANCE PARAMETER**

Accuracy ^①	<2.0E-12
Warm-up Time (typical)	30 min
Reproducibility	<1.2E-12
Stability	Allan Deviation
Averaging Time (s)	
10 ⁰	<1.2E-11
10 ¹	<8.5E-12
10 ²	<2.7E-12
*10 ³	<8.5E-13
*10 ⁴	<2.7E-13
*10 ⁵	<8.5E-14
*floor	<5.0E-14
SSB Phase Noise Offset (Hz)	5MHz
10 ⁰	≤95 dBc
10 ¹	≤130 dBc
10 ²	≤145 dBc
10 ³	≤155 dBc
10 ⁴	≤155 dBc
10 ⁵	≤155 dBc
Settability	
Range	±1E-9
Resolution	1E-15
Control	via RS232 port

^① 100% verified & calibrated against Symmetricom in-house standard.

*excluding environmental effects

• Panel Indicators

Power	Green LED indicates there is power to the instrument
Lock	Green LED indicates proper operation.
Alarm	Red LED indicates the improper operation

• Power Requirements

	AC
Operating Voltage	85 to 265 V
Frequency Range	47 to 63 Hz
	400 Hz
Power	
(operating)	110 VA, 65 W, 0.6 A @ 115 V
(warm-up)	140 VA, 90 W, 0.8 A @ 115 V

• RF Outputs

Frequency	1 each 5 MHz & 10 MHz
Amplitude	1 Vrms
Harmonic	<-40 dBc
Spurious	<-80 dBc
Connector type	BNC
Load Impedance	50 ohms
Location	rear panel

• Dimension

Height	3.50" (88.9 mm)
Width (front panel)	19.00" (483 mm)
(instrument)	17.31" (440 mm)
Depth	15.0" (381 mm)

• Weight

≈28 lbs (≈13 kg)

•1 PPS Output

Frequency	One pulse per second
Amplitude/wave shape	>3.0 V pk into 50 ohms
Width	20 μs
Rise Time	<5 ns
Jitter	<1 ns rms
Connector type	BNC
Location	rear panel

TABLE 1-1 SPECIFICATIONS, *Cesium Frequency Standard* (at 25°C unless otherwise specified)
(continued)

GENERAL

Mating Connectors	
RS232 (rear panel, DTE)	9 pin male D-connector (mate: DA9S, ITT Cannon or equal)
ALARM RELAY	9 pin female D-connector (mate: DA9P, ITT Cannon or equal)
Chassis Ground	#8 x .43" stud with 8-32 nut
1 PPS, 10, 5 MHz Outputs	BNC, rear panel
Fuses	
AC Input – F1	T 1.0 A/250 V for 85 to 264 V ac, 50 to 60 Hz
Environment	
Operating	
Temperature	0 to 50°C,
Humidity	95% up to 50°C
Non-operating (transport)	
Temperature (storage)	-30 to +70°C
(short-term)	-40 to +75°C
Magnetic field	0 to 2 gauss
Shock	30 g/11 ms, 3 axis
Vibration	MIL-STD-167-1
Altitude (operating)	0 to 50,000 ft

1.4 PREPARATION FOR SHIPMENT

To turn off *Cesium Frequency Standard* prior to shipment, remove ac power and all other connections. Package the instrument in its original packing if possible. If returning the instrument to Symmetricom, contact the service department at (978)927-8220 to let them know it is being returned and the unit's serial number.

1.5 INSTALLATION

1.5.1 Mounting

The *Cesium Frequency Standard* is designed to be mounted in a standard 19-inch equipment rack and take up 2 UI of vertical space (3.5 □).

1.5.2 Power Connection and Fuses

The *Cesium Frequency Standard* is powered from an ac source by a detachable power supply cord. This instrument input connector is the disconnect device. The ac fuse (and a place for a spare) is located in the ac connector on the rear panel. The fuse may be checked or changed by removing the power cord, and gently prying open the fuse tab on the ac connector. Refer to Table 1-1 for power supply and fuse requirements.

1.5.3 Alarm Connections

The *Cesium Frequency Standard* provides for an ALARM (operation has been or soon will be compromised). One set of form-C relay contacts is provided on the 9-pin connector labeled ALARM. Refer to Table 1-2.

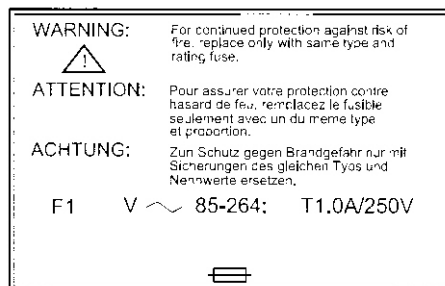
1.5.4 RS232 Connection

The *Cesium Frequency Standard* has one standard 9-pin RS232 connection. Pin-outs are listed in Table 1-2.

TABLE 1-2 RS232/ALARM CONNECTIONS

PIN	RS232 (DTE, male)	ALARM (FEMALE)
1		+12 V EXT OPTION
2	RXD	+12 V RETURN (GROUND)
3	TXD	
4	DTR	MAJOR (COMMON)
5	GND	MAJOR(FAULT=CLOSED)
6		MAJOR(FAULT=OPEN)
7	RTS	
8		
9		

1.5.5 Safety considerations



NOTE: This instrument must be operated only as specified by the manufacturer. Use, other than as specified, may compromise the safety precautions of the system.

NOTE: To disconnect power to this instrument, remove the ac power cord from the rear panel. This is the disconnect device – there is no ON/OFF switch.

WARNING: For continued protection against risk of fire, replace only with same type and rating fuse. Fuse specifications are contained in Table 1-1 and the yellow label on the unit's rear panel. Refer to paragraph 1.5.2 for fuse replacement instructions.

WARNING: Covers on this instrument must not be removed except by trained service personnel.

1.5.6 Cleaning

This instrument may be cleaned while in operation with a clean, dry cloth. If further cleaning is required, turn the instrument off, clean with a damp cloth and mild detergent, and wipe with a dry cloth.

SECTION 2

OPERATION

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SECTION 2. OPERATION

2.1 INTRODUCTION

This section describes procedures for turn-on, turn-off, and using the SYMMETRICOM *Cesium Frequency Standard*.

2.2 TURN-ON PROCEDURE

- 1) Plug in the *Cesium Frequency Standard*.
- 2) Observe that the POWER and ALARM indicators are illuminated. In addition, the ALARM relay is activated.
- 3) Wait for up to 30 minutes, and note that the ALARM indicator turns off and the LOCK indicator turns on. The ALARM relay is reset. The outputs are ready to use.

Note: The factory default for ALARM operation is “warning mode,” which is as described above (non-latching operation). The user may change operation to “critical mode” as described in the next chapter. In critical mode, the ALARM is latching, and must be reset by the user over the RS232 port, by issuing the RESET ALARM command, as described in the next chapter.

2.3 TURN-OFF PROCEDURE AND RESTARTING

- 1) Unplug the ac power connector from the rear panel. This is the turn-off device.
- 2) To restart the instrument, re-connect the ac power connector on the rear panel and wait for the LOCK indicator to illuminate.

2.4 CONTROL AND MONITORING VIA THE RS232 PORT

The SYMMETRICOM *Cesium Frequency Standard* may be controlled or monitored via the RS232 ports. The software interface uses a proprietary interface, described in Section 3.

2.5 1 PPS OPERATION

The 1 PPS output remains off until the unit locks. The unit will provide a stable output as long as the unit remains LOCKed.

To synchronize the 1 PPS output to an external source, connect the source to the SYNC input and issue a PPS SYNC ENABLE command as described in Section 3.

SECTION 3

RS232 INTERFACE

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SECTION 3. RS232 INTERFACE**3.1 INTRODUCTION**

This section describes the protocol for the RS232 Interface and includes general communication parameters as well as the command list.

3.2 GENERAL PARAMETERS

The default for the RS232 interface parameters are 9600 baud, 7 bits, odd parity, 2 stop bits.

3.2 OPERATING NOTES

Only two operating functions require the use of the RS232 interface: W22—*Arm 1 PPS Sync Circuit* and A18--*Set Restart Fault Level*. The other commands are for performance monitoring, diagnostic and factory use.

3.3 CESIUM COMMAND REFERENCE

Commands are sent to the system via RS232. The Cesium III command set is backwards compatible with the 5045A/4201A command set. Several new commands support the new capabilities of the Cesium III system.

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

Element	Description
STX	002
	Space character
[<DATA>]	Data: this string is of variable length
<IDENT>	5 character unit identification number - * Note 1
<Function Code>	Function code, see table
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

Command	Description	Data Field
Standard functions		
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 e-15	Sign plus 6 digits
Command	Description	Data Field
Standard functions		
W02	Unused	
W03	Time updating (advance or retard 10 MHz phase by n nanosecond)	Sign plus 4 digits
W04	Reset time updating (halts a time updating operation.	No data required
W05	Disable the C-Field Servo	No data required
W06	Enable the C-Field Servo	No data required
W07	Unused	
W08	Obsolete... Sets the 5045 compatible day of	9 digits:

	year and time	3 digit day 2 digit hour 2 digit minute 2 digit second
W09	not used	
W10	Set the servo filter order and time constant. The servo filter order is fixed at 1 in the Cesium III line of products	6 characters: 1 filter order 2 space 3-6 floating point number
W11	Set frequency offset (not saved in NVRAM). The offset is in parts e-15	Sign plus 6 digits
W12	Mute signals	No data required
W13	Un-mute signals	No data required
W14	Mute override	No data required
W17	Alarm relay cut off	No data required
W18	Clear event log	No data required
W22	Arm 1pps sync circuit. Issue this command after connecting a 1pps source to the Cesium III. The sync will remain armed for 3 seconds.	No data required

Special functions		
T*1	Obsolete (Remote control off)	No data required
T*2	Obsolete (Remote control on)	No data required
D*1	Return Variables (250 characters)	No data required
D*2	Return Constants (129 characters)	No data required
D*3	Retrieve Event Log	No data required
D*4	Report Extended status...Alternate report of internal system status, using higher resolution numbers and comma separated values.	No data required
D*5	Report the contents of the internal non volatile memory (NVRAM)	No data required
S01	Set operating mode to clock servo only. This disables the microwave servo, the c-field servo, and the gain servo.	0 = return to normal clock operation 1 = servo only mode
S02	Disable/Enable VCXO servo	0 = off 1 = on
S03	Disable/Enable C-Field servo	0 = off 1 = on
S04	Disable/Enable Microwave power servo	0 = off 1 = on
S05	Disable/Enable the gain servo	0 = off 1 = on
S06	Set VCXO Control Voltage	A floating point number between 0 and 5.8
S07	Set Numeric and DAC gain values	DAC, numeric
S08	Set C-Field Control Voltage	A signed floating point number between -2.5 and +2.5
S09	Set microwave power Control Voltage	A floating point number between 0 and 5

Console functions		
C01	Set unit number.	5 digits
C02	Memorize nominals	No data required
C03	Return software version	No data required
C04	(obsolete)Set language (English/French/German)	1 digit 1=english 2=french 3=german
C05	Set serial port parameters	Baud, data, parity, stop bits
C06	Set Eudics Message	9 characters
New functions		
A01	Set Test Mode 1... This performs internal diagnostics	0 = off 1 = do test
A02	Set Test Mode 2... This sets the dds to one of the 9 interrogation frequencies	0= off 1-9=select DDS frequency
A03	Set Test Mode 3... Program the Gain DAC to a fixed value	0 = off 1-256 =
A04	Set the dds to	A 48 bit dds control word (hex) Setting the data to 'off' will restart the clock....
A05	Sweep the dds.	48bit start, 48 bit delta f, 4 digit number of steps
A06	Set Date (year, month, day)	mm/dd/yy
A07	Set Time (hour, minute, second)	hh:mm:ss
A08	Return Date and Time	
A09	Set Daylight savings mode	1=on 2=off
A10	Return Daylight Savings mode	
A11	Leap Second insertion at next interval	0=Enabled 1=Disabled
A12	Set power on hours... this allows you to override the permanent record of power on hours	integer
A13	Set Expected tube service life (in months)	3 digits
A14	Return power on hours	No data required
A15	Set Response mode	0 = normal 1 = verbose
A16	Reset NVRAM to default values	No data required
A17	Set Manufacturing Date	Mm, dd, yy
A18	Set Restart Fault Level	1 = restart is critical fault 0 = restart is not a critical fault

Data returned by the “Return Variables” command

Variable	Field	Example
STX CR LF	1-3	
Unit serial number	4-10	ID00025
Day Meter	12-14	537
Time (hour minute second)	16-25	16h13mn22s
First or second order servo loop	27	2
Operating mode	29-31	R+Z
Alarms state * Note 2	33-54	ALM:00(00,00,00,00,00)
C-Field adjustment	55-59	C +015
Frequency fine tuning	61-68	F -006
24v power supply	70-76	+24.8V
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* + 0008
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	AO + 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
Internal case temperature	175-180	T+27.7
+15.5V power supply	182-187	+15.1V
-15.5v power supply	189-194	-16.2V
Quartz oscillator cold/warm	196-198	Olc
Cesium oven supply voltage	200-205	F0008.0
Mass spectrometer voltage	207-212	VS18.9
Cesium beam tube Ionizer voltage	214-219	VF1.5
C-Field coil current	221-226	IC14
HTEM control voltage	228-233	HT10.6
Ion Pump current	235-239	IP025
Allan deviation of clock servo voltage over 30 seconds	241-247	+137 mV
CR LF ETX	248-250	

Data returned by the “Return Constants” command

Variable	Field	Example
STX CR LF	1–3	
Unit serial number	4–10	ID00025
Day Meter	12–14	006
Time (hour minute second)	16–24	04h54mn32s
Spectrometer voltage nominal	26–33	Vs 14.0V
Tube ionizer voltage nominal	35–44	Vf 1.07V
Gain DAC	44–51	GDAC 008
F(t°) correction model at –15°C	48–54	–15:+10
F(t°) correction model at +15°C	54–59	+15:+00
F(t°) correction model at +45°C	61–67	+45:–03
F(t°) correction model at +75°C	69–75	+75:+04
CR LF	84–85	
12.6MHz level nominal (J1 max)	86–92	Pi+0345
Zeeman offset (Assymetry compensation)	94–100	Oz–0045
Auxiliary output signal frequency	102–112	Fo:05.0MHz
Console mode language	114–119	CDU: GB
Comments	121–134	TXT(1234567890)
Eudics program version	136–138	370
Eudics program revision	140–142	1.8
CR LF ETX	143–145	

3.4 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 time stamps. The first is a 6 byte calendar date, the second is a 32 bit value representing the total system power on hours.

3.5 TROUBLESHOOTING

If the ALARM activates and remains lit indicating a failure of the 4310, call Symmetricom Customer Service for instructions.

Table 3-6 lists the two-digit numeric fault codes and gives description of each. If any of the following fault codes are observed, refer to the comment in the Comments column. If unable to resolve the cause of the fault, contact Symmetricom Customer Service for further instructions.

Note 1 *The five zero's are the "five digit unit identification number". One can use the last five digits of the actual serial number (marked on each unit), or one can use five zero's as in the example shown above.*

Note 2 *The data returned by the "Return Variables" command, in fields 33 thru 54 are the Alarms and the four possible system states. By reading these, one can know the state of the instrument. The data is presented as follows:*

ALM:ss(00,00,00,00,00)

where ss indicates the system state

<i>00</i>	<i>operation</i>
<i>01</i>	<i>warm up</i>
<i>10</i>	<i>minor fault</i>
<i>11</i>	<i>major fault</i>

The digits enclosed in parentheses are fault codes. See the System Fault Codes Table below.

Table 3-6, Fault Messages

Fault Code	Description	Comment
01	Clock Peak to Background	<1320 or >3080 mV
02	Clock Pedestal Symmetry	>50 mV
03	Zeeman Pedestal Symmetry	>160 mV
04	Mass Spectrometer	>5% or nominal (± 0.7 V)
05	C-field Current	<16.0 or >22.0 V
06	Electron Multiplier Supply	<7.0 or >13 V
07	ADC	
08	VCXO Control Voltage	<10% or >90% (± 4000 mV)
09	Case Temperature	>80°C
10	Not used	
11	Not used	
12	+5 V Supply	<4.75 or >5.25 V
13	+15 V Supply	<13.5 or >16.5 V
14	-15 V Supply	>-13.5 or <-16.5 V
15	Not used	
16	Unit Restarted	
17	Module configuration not set	
18	Digital Gain at lower limit	= 1
80	Software Failure	
81	Event Log Invalid	
F1	Cesium Oven Warm-Up	>10.0 V (after warm-up)
F2	OCXO Oven Warm-Up	>2.5 V after initial warm-up
F3	Ionizer Filament	>± 0.16 V of nominal
F4	Ion Pump Current	>175 μA
F5	+24 V Supply	<17 or >24 V