PRS-50
Cesium Primary Reference Source

User Guide

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NOTE

The contents of any amendments may effect operation and/or maintenance of the equipment..

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1 General Information

The Datum PRS-50 Cesium Beam Primary Reference Source is an accurate and stable frequency reference designed for telecommunications Stratum 1 applications.

1.1 Introduction

This manual contains the following sections:

- Section 1 — Detailed performance and installation specifications
- Section 2 — Operating Procedures
- Section 3 — Theory of Operation
- Appendix A — Transaction Language 1 (TL1) Syntax

1.2 Summary Description

The Datum PRS-50 Cesium Beam Primary Reference Source is a primary frequency reference with fully automatic operation via microprocessor control. It provides a Stratum 1 quality signal without the need of any external reference. The PRS-50 has a 2-year warranty on the electronics and a 12-year warranty on the cesium beam tube. The unit has a field serviceable cesium module. Its replacement procedure is explained in Section 2.9, Service.

The major function of the Datum PRS-50 is to produce two accurate and stable DS1 signals (1544 Kbps) or E1 signals (2048 Kbps) for telecom network synchronization. To accomplish this, a cesium beam tube resonator is used to stabilize the output of a quartz crystal oscillator which provides the frequency source for the output generators.

A microprocessor performs the following tasks:

- Digital demodulation and integration of the servo loop signals
- Monitoring of system parameters
- Control of adaptive servos
- Diagnostic functions to aid in troubleshooting
- Communication for monitoring and control

A complete list of performance characteristics is provided in Table 1.3-1, and the front panel view in Figure 1.3-1.

1.3 Options

PRS-50 with DS1 outputs	P/N 25481271-001-0
PRS-50 with DS1/TL1 outputs	P/N 25481271-002-0
PRS-50 with E1 outputs	P/N 25481271-003-0
PRS-50 with E1/TL1 outputs	P/N 25481271-004-0

1.3.1 DS1 Version

A PRS-50 ordered in this version provides DS1 (1544 Kbits) telecom signals in either SF (D4) or ESF format. The output format is user selectable by jumper settings. Line length settings are also selectable for various cable lengths up to 655 feet. In ESF operation a Sync Status Message is included in the output signals which identifies the source as a PRS (Stratum 1) source. See Table 1.3-1 for specifications.

1.3.2 E1, 2048 KBPS Version

A PRS-50 ordered in this version provides ITU-T 2048 Kbits (E1) telecom signals. The outputs are framed in accordance with ITU-T Rec. G.704. These outputs are available in either 120 Ohm balanced or 75 Ohm unbalanced form. See Table 1.3-1 for output specifications.

1.3.3 TL1 Interface Option

The TL1 Option is a plug-in printed circuit board located inside the unit (behind the front panel). See Figure 1.6-4. This Option provides a software interface capability using Bellcore Transaction Language 1 (TL1). In addition it provides a second RS-232 interface port (also in TL1) for simultaneous local and remote communications. One port is typically used for the local craftsperson communication, and the second is used for the operating system (OS) communication or for pass-through communications to other Datum timing equipment.

The user software provided with the TL1 Option is Windows 3.1x (or higher) compatible and provides a graphical user interface for both commands and data display. This software is intended primarily for demonstration purposes. The user may also communicate with the PRS-50 using the standard TL1 commands described in Section 2 from an ASCII terminal or OS. The TL1 commands are compatible with Datum's ITU-T compliant TMN-NSM or NSM management system.

Figure 1.3-1: *PRS-50 Front View*

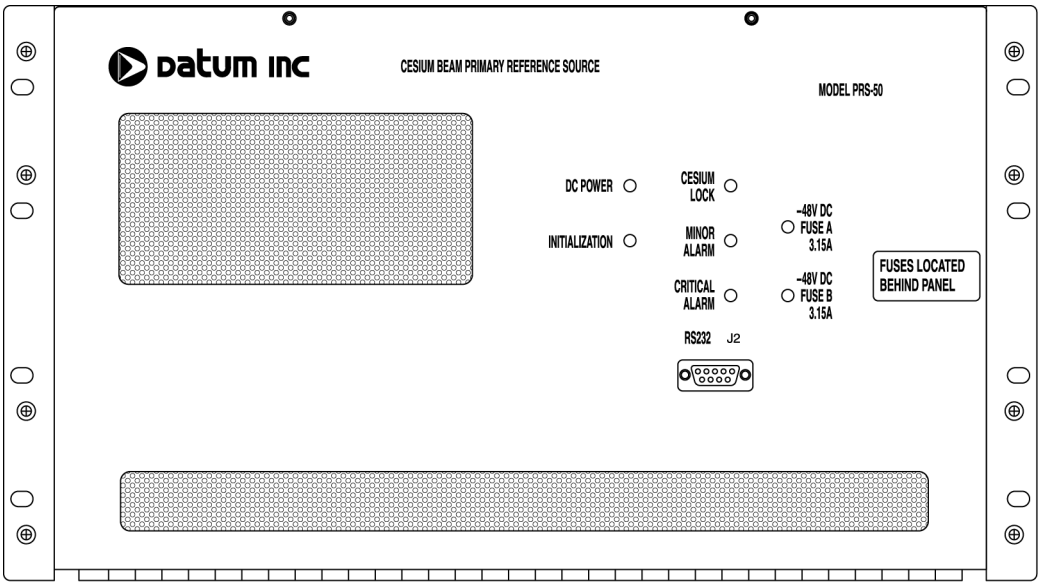


Table 1.3-1: Specifications, Datum PRS-50

(All values at 25° C unless otherwise specified)	
PERFORMANCE	
Accuracy, Calibrated to	$<1 \times 10^{-12}$
Accuracy (25°C ± 5°C)	$\pm 2 \times 10^{-12}$
Accuracy (over environment)	$<3 \times 10^{-12}$
Retrace (reproducibility)	1.2×10^{-12}
Stability $_y$ ( )	
Averaging Time ( )	
1 s	3.0×10^{-11}
10 s	1.3×10^{-11}
100 s	3.0×10^{-12}
1,000 s	9.5×10^{-13}
10,000 s	3.0×10^{-13}
Warm-Up Time (typical)	30 minutes
OUTPUTS	
Telecom Signals	2 each at 1544 or 2048 kbps
1544 Kbps	ANSI T1.102 DS1 (1544 Kbits) selectable framing: SF(D4) or ESF with Stratum 1 Sync Status Message, 100 Ohm balanced symmetrical pair.
Format	Framed all ones, B8ZS/AMI
Connector	Rear panel, wire-wrap pins, x2

Table 1.3-1: Specifications, Datum PRS-50

2048 Kbps	ITU-T Rec. 2048 Kbits (E1), 120 ohm balanced symmetrical pair or 75 ohm unbalanced with G.704 framing and PRS Sync Status Message
Format	CCS, HDB3
Connector	Rear panel, wire-wrap pins, x2
TTL Signal	
Frequency	1, 5, or 10 MHz (selected via RS232 port)
Level	> 2.2 V into 50 ohms
Connector	Rear panel, BNC, x1
CONTROL & MONITOR SOFTWARE	Refer to Section 2 for set-up details
DOS environment (without TL1 Option)	Monitor program (PC application)
Windows 3.1x environment (with TL1 Option)	Datum Instrument Monitor (PC application)
GENERAL	
Power Requirements	Dual DC inputs
Operating Voltage	-48 Vdc nominal (-36 to -62 Vdc)
Power (operating)	40 W
Power (warm-up)	55 W
Fuses	
External DC Input (x2)	3.15 A, 250 V, fast acting
Connectors	
DC Input A	#6 screw terminal block
DC Input B	#6 screw terminal block
RS-232	9 pin male D-connector (both front and rear) (mate: DA9S, ITT Cannon or equal)
Craft (front panel)	Active only with TL1Option
Remote/Craft (rear panel)	Active for all configurations
Chassis Ground	Banana post with screw-down nut
Alarm - Critical & Minor	#6 screw terminal block with wire-wrap pins
Dimensions	
Height	10.5" (26.7 cm)
Width	18.125” (64.0 cm)
Depth	10.1" (25.7 cm)
Weight	36.5 lbs. (16.6 kg)
Mounting	Mounting ears provided for 19” or 23” racks or cabinets
ENVIRONMENT	
Temperature, Operating	0 to 50°C
Temperature, Non-Operating	-40 to +75°C
Humidity, Operating	95%, non-condensing
Magnetic Field	0 to 2 gauss DC @ 50, 60, or 400 Hz
Altitude	200 ft. below sea level to 12,000 ft. above sea level

1.4 Storage

During storage of the PRS-50, there are two factors to consider: cesium beam tube vacuum and shelf life.

1.4.1 Cesium Beam Tube Vacuum

If extended periods of storage (>6 months) are anticipated, periodic storage-mode operation cycles should be performed in order to maintain the tube vacuum. The minimum period of operation is 30 minutes for every six months of storage time. Refer to Section 2 for the turn-on procedure.

1.4.2 Cesium Beam Tube Shelf Life

Extended high temperature storage (>50 ^{o}C) reduces the expected operating life of the cesium beam tube. The reduction in tube life expectancy for each year at 70 ^{o}C is approximately 4 months.

1.5 Preparation for Shipment

To turn off the Datum PRS-50 prior to shipment, remove the external DC power. Remove all external connections, and remove the unit from the rack or cabinet. Place the unit in the HAZMAT shipping container.

1.5.1 Hazardous Material (HAZMAT) Shipping Considerations

Datum 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 Datum PRS-50 presents no danger since the cesium is encased within a vacuum sealed metal enclosure. However, hazardous materials, depending upon their specific nature, are subject to certain shipping regulations of the USDOT and the IATA. These regulations govern the shipping case as well as its labeling.

The initial shipment of every Datum cesium standard complies with HAZMAT regulations by using a shipping case which 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

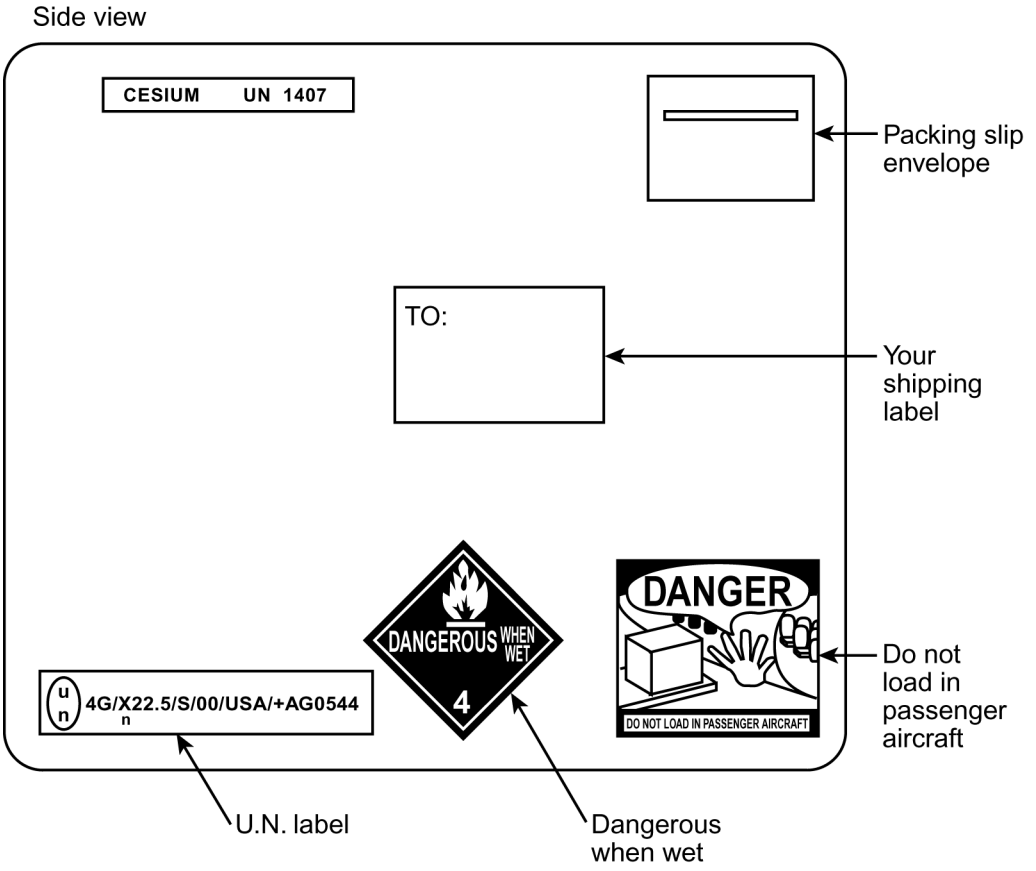
DANGER – NO PASSENGER AIRCRAFT

CESIUM UN 1407.

1.5.2 Shipping Procedure

The shipper is responsible for the overall condition of the HAZMAT shipping case; i.e., latches locked (if applicable), no visible damage to case and to properly place all labels on the case, etc. See Figure 1.5-1 for an illustration of 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 1.5-1: *Typical Label Placement*



1.5.3 Shipping Carriers

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, call Datum Technical Service at 512-721-4000.

The following information is typically requested by the carrier:

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

NOTE

For more information about returning products to Datum, see Section 2.10.

1.6 Installation

This section provides unpacking instructions and installation procedures for the PRS-50 as well as, warnings, cautions, notes, and recommendations that pertain to the procedures being performed. To prevent serious injury and/or equipment damage **do not** ignore these safety, environmental, and operational messages.

WARNING

For continued protection against risk of fire, ensure that only the specified fuse type and rating are used. Fuse rating is contained on the instrument's front panel and in Table 1.3-1.

CAUTION

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

CAUTION

To avoid electrostatic discharge (ESD) damage to sensitive internal parts in the PRS-50, observe proper ESD handling procedures.

1.6.1 Environment

When installing the instrument, consideration should be given to standard environmental factors (temperature, humidity, vibration, etc.) and to the presence of magnetic fields that might affect the accuracy of the Datum PRS-50. Avoid installing or using the instrument near large motors, generators, transformers, or other equipment which radiates strong AC or DC fields of 2 gauss or more.

1.6.2 Mounting

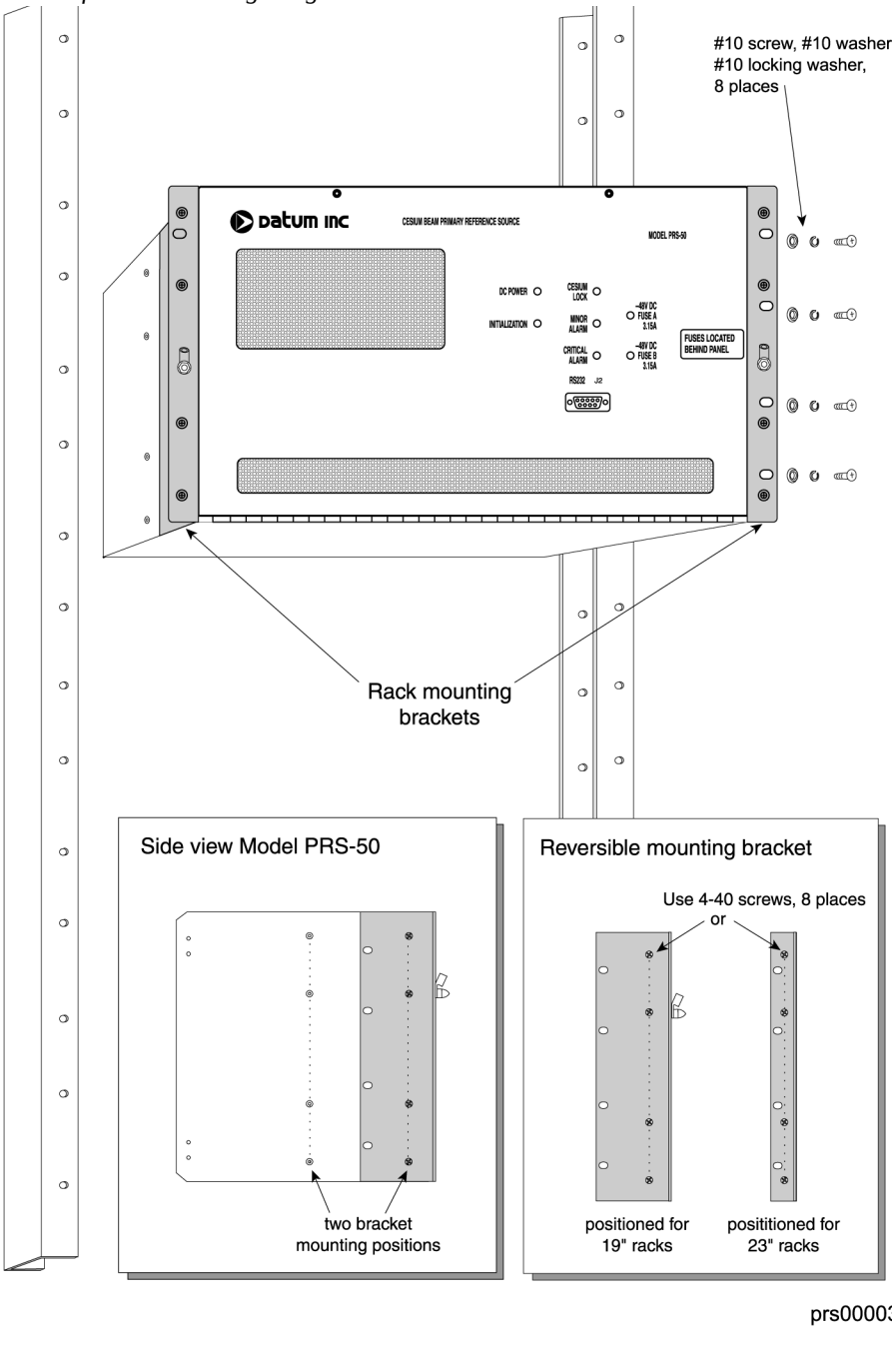
The Datum PRS-50 is designed to be mounted in a standard telecom equipment rack. The front panel occupies a height of 10.5 inches. The Datum PRS-50 is 10.1 max. inches deep and weighs approximately 36 lbs.

The Datum PRS-50 comes equipped with removable rack mounting brackets. These brackets, which are reversible, may be positioned in different configurations to satisfy a variety of mounting requirements, including mounting in a standard 19 or 23 inch rack. See the shelf mounting diagram in Figure 1.6-1. The brackets may be mounted 0 or 3.625 inches behind the Datum PRS-50 front panel.

CAUTION

The PRS-50 is convection cooled. We recommend that you allow for a one rack unit (1.75 in. or 4.44 cm.) space above and below the unit for cooling..

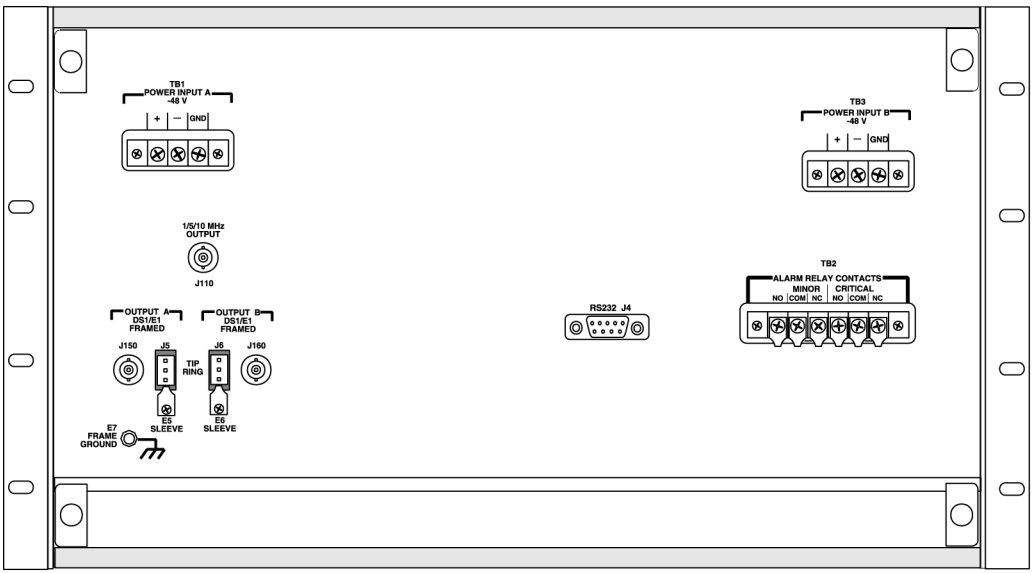
Figure 1.6-1: *Shelf Rack Mounting Diagram*



1.6.3 Electrical Connections

All permanent electrical connections are made at the rear panel. Refer to Figure 1.6-2 for the location and contact designation for the various connectors. Note that all cables may be tied off to a strain relief bar on the rear panel, and there is also a clear, removable safety cover for the rear panel.

Figure 1.6-2: *PRS-50 Rear View—Standard Configuration*



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1.6.3.1 External DC Connections

The Datum PRS-50 is powered from dual external DC sources. Refer to Table 1.3-1 for power supply and fuse requirements. Note that both power inputs A and B must be applied to satisfy the minor alarm criterion. Also note that the “return” side (+) of the 48 volt supply is connected to the screw terminal marked “+”. The screw terminal marked “GND” may be connected to the frame ground, in accordance with local practice, but is isolated from the DC return.

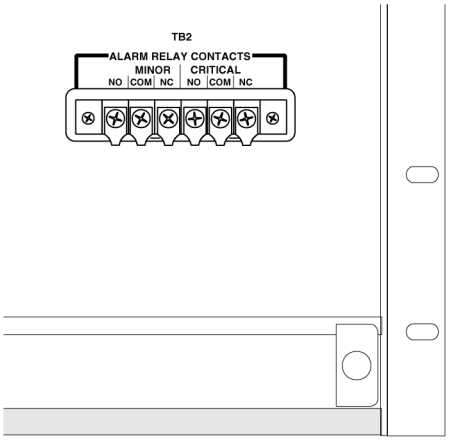
The Datum PRS-50 employs an internal DC-DC converter to provide a wide input voltage range as well as electrical isolation between the DC input and chassis ground. Either side of the DC input may be at chassis ground potential. The external DC inputs are protected against reverse polarity connection by series diodes.

1.6.3.2 Alarm Connections

The Datum PRS-50 provides for MINOR alarms (attention required at operator’s convenience) and CRITICAL alarms (Stratum 1 synchronization has been or soon may be compromised). One

set of form-C relay contacts, 1 Amp rating, is provided for each alarm on terminal block TB2. Figure 1.6-3 is an illustration of the terminal block. Connect alarm relay contacts on TB2 to the external monitoring equipment per user's alarm monitoring scheme. Connect the alarm contacts with a #6 ring or spade terminal. Minor and critical alarm connections are available with both "normally closed" and "normally open" contacts.

Figure 1.6-3: *Alarm Closure Terminal Block*



1.6.3.3 RS-232 Connections

The PRS-50 has two RS-232 connections: J4 is a remote/craft interface on the rear panel and is active in all configurations. J2 is a craft interface located on the front panel and is activated with the TL1 Option and is functionally the same as J4. All the connections are DTE, with pin-outs described in Table 1.6-1. A null-modem cable is provided with the unit to connect the PRS-50 to a RS-232 port on a PC. Note that the communications protocol depends on the options provided and is fully described in Section 2, Operation.

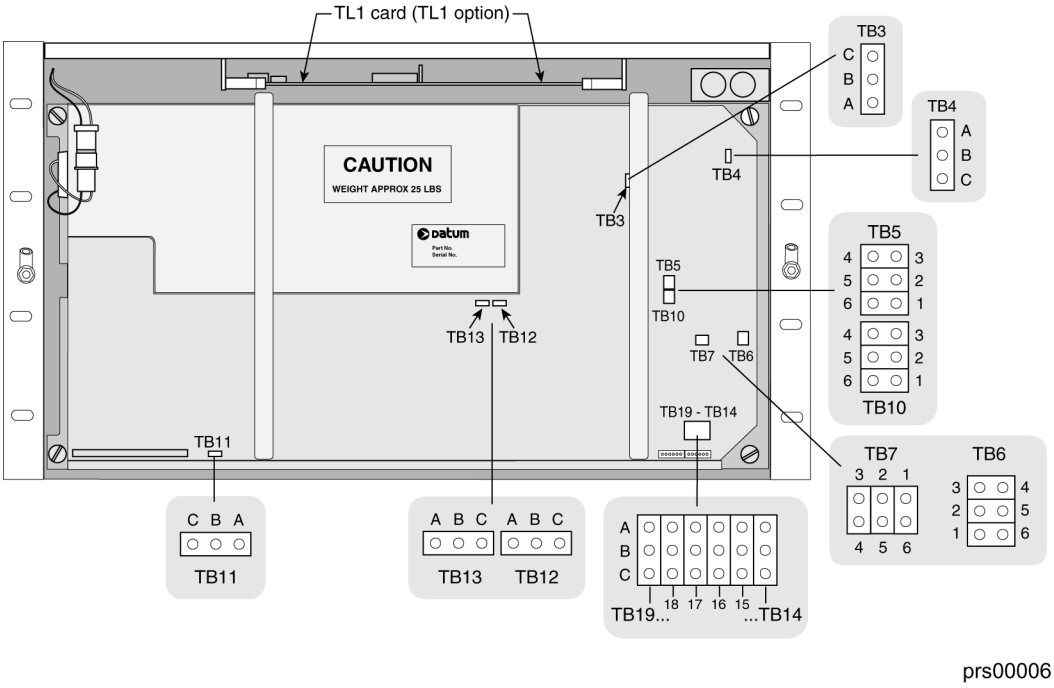
Table 1.6-1: RS-232 Connections

J2 Front Panel (Craft)		**J4 Rear Panel (Remote)**	
PIN	FUNCTION	PIN	FUNCTION
3	TXD	3	TXD
2	RXD	2	RXD
7	RTS	7	RTS
8	CTS	8	CTS
5	GND	5	GND
1	DCD	1	DCD
4	DTR	4	DTR

1.6.4 Jumper Settings for Telecom Outputs

Jumpers are provided to configure the telecom output signals to the desired settings. The location of these jumpers is shown in Figure 1.6-4 below. Refer to the labels on the inside front door of the unit for the proper jumpers for framing and line compensation. These settings are also described below in Table 1.6-2 through Table 1.6-6.

Figure 1.6-4: *Terminal Block Locations*



1.6.4.1 Framing and Frequency Jumper Settings

Output framing format/signaling selection is done by setting the jumpers on TB-5 and TB-10, located on the right-hand side of the main PCB inside the unit. See Table 1.6-2.

Table 1.6-2: Framing and Frequency Jumper Settings

Units equipped with DS1 outputs	
Desired DS1 format	**TB5 and TB10 jumper settings**
D4 (superframe)	2-5
ESF (extended superframe) SSM-enabled	3-4 (default)
Units equipped with E1 outputs	
E1 format	**TB5 and TB10 jumper settings**
E1 CEPT	1-6 and 2-5

Verify that the frame generator clock frequency has the correct jumper setting for TB4, which is located on the upper right-hand side of the main PCB inside the unit. See Table 1.6-3.

Table 1.6-3: TB4 Jumper Settings

For units equipped with:	TB4 jumper setting
DS1 outputs	A-B
E1 outputs	B-C

NOTE

The PRS-50 outputs are not field changeable between DS1 and E1. The jumpers must be in the correct positions per the above settings.

All other jumpers in the unit are not user selectable and should be installed as shown in Table 1.6-4.

Table 1.6-4: Fixed Jumper Settings

Jumper designator	Jumper setting
TB2	Shunt installed
TB3*	A-B
TB9*	none installed
TB11 RS-232, handshake on	B-C
TB12	A-B
TB13	A-B
* may not be available on all versions of the unit	

1.6.4.2 Line Compensation Jumper Settings

Line compensation is selected on jumper blocks TB6 (CH1) and TB7 (CH2). The factory default DS1 outputs is the shortest length, 0 to 133 feet. Refer to the matrix below to ensure that the jumpers are set to the correct position for the length and type of cable being used for the outputs.

Table 1.6-5: Line Length Compensation Jumper Settings

Units equipped with DS1 outputs				
TB6 and TB7 jumper locations			Output cable length (feet)	Cable types
1-6	2-5	3-4		
		X	0-220	MAT and ICOT
	X	X	220-440	
X		X	440-665	

Table 1.6-5: Line Length Compensation Jumper Settings

		X	0-133 (default)	ABAM and PIC
X	**X**		133-266	
	X		266-399	
X			399-533	
(no jumper)			533-655	
Units equipped with E1 outputs				
TB6 and TB7 jumper locations			**Cable types**	
1-6	**2-5**	**3-4**		
X	**X**	**X**	**ALL**	
NOTE: X indicates a jumper installed in this position				

1.6.4.3 Output Timing Signal Jumper Settings

Output timing signals with DS1 or E1 outputs are available on the rear panel in either balanced (wire-wrap) or unbalanced (BNC) connectors. Selection of the desired output type is accomplished by setting the jumpers on TB14 through TB19 as shown in Table 1.6-6 .

Table 1.6-6: Output Timing Signal Jumper Settings

	Channel 1			**Channel 2**		
	TB14	**TB15**	**TB16**	**TB17**	**TB18**	**TB19**
Balanced (wire-wrap)	B-C	A-B	A-B	B-C	A-B	A-B
Unbalanced (BNC)	A-B	B-C	B-C	A-AB	B-C	B-C

2 Operation

2.1 Introduction

This section describes the operational procedures for turn-on and monitoring of the Datum PRS-50 Cesium Primary Reference Source.

2.2 General Information

Except for the application of power, no specific user actions are required to turn on the Datum PRS-50 and obtain the specified output signals. Application of DC power initiates the warm-up and automatic lock acquisition sequence. Refer to Figure 1.3-1 for an illustration of the Datum PRS-50 indicators and to Table 2.2-1 for a description of the front panel indicators.

Table 2.2-1: Front Panel Indicators

Indicator name	Description
CESIUM LOCK	Turns green when the frequency control loop is stable. Outputs are on. Indicates normal operation.
MINOR ALARM	Turns amber when minor alarm is present
CRITICAL ALARM	Turns red when critical alarm is present
INITIALIZATION	Turns amber during execution of the start-up routine to indicate that warm-up is in progress. Monitoring of faults is masked during initialization. The critical alarm relay contacts (normally open) are closed and the outputs remain off during this state.
DC POWER	Turns green when DC power is present
-48 VDc FUSES A and B	Turn red when internal fuse is blown

NOTE

CRITICAL and MINOR alarms are listed in Table 2.8-2, Fault messages. CRITICAL alarms will mute all outputs.

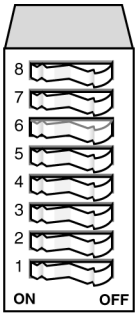
2.3 Control and Monitoring Via the RS-232 Ports

The PRS-50 is controlled or monitored via the RS-232 ports. The communication interface to the PRS-50 is either Datum software or TL1 (Transaction Language 1). The Datum software, MONITOR.EXE (DOS) and Datum Instrument Monitor (DATUM IM) (Windows), are described in Section 2.4.1 and Section 2.5.1.

The TL1 Option is a plug-in printed circuit board as shown in Figure 2.9-1, located behind the front panel. With the TL1 Option, the PRS-50 may be accessed directly from either the Datum software, DATUM IM, or from an ASCII interface (a terminal program such as Procomm or MS Terminal, etc.). The ASCII interface and TL1 command list for TL1 is described in Section 2.8.1.

Table 2.3-1: RS-232 Interface Options

Software required	**Without TL1 option: proprietary interface** (J4 only, rear panel, dipswitch* bank all on)	**With TL1 option: TL1 interface** (J2 and J4: front/rear, dipswitch* bank all off)
PC software	MONITOR.EXE (DOS)	DATUM IM (Windows)
ASCII interface		TL1 (see Appendix A)
*Mounted on the inside of the front panel.		



Dipswitch bank
All in the ON position

2.3.1 RS-232 Communications Port Parameters

The default RS-232 communications port parameters for both PC-based programs as well as both PRS-50 ports are: 2400 baud, 7 bits, odd parity, 2 stop bits (2400, 7,O,2), no software handshake. These settings may be changed by the user, and the new settings are saved in non-volatile memory and will be used when the unit is restarted.

NOTE

The port parameters of the communications program must be set to match those of the PRS-50 interface settings. The RS-232 ports are configured as DTE, and the computer serial port (IBM compatible) is normally also configured as DTE – thus a null modem cable or adapter is required. A null modem cable with DB9 connectors is provided with the unit.

2.4 Turn-On Procedure (Without TL1 Option)

- Ensure that the unit is properly grounded according to the site's grounding requirements. Refer to Section 1.6.3, Electrical Connections for details. Apply DC power to the **POWER INPUT A ,TB1** and **POWER INPUT B, TB3** on the rear panel of the PRS-50.
- Observe that the green **DC POWER** and amber **INITIALIZATION** indicators are illuminated. **FUSE A** and **FUSE B**, **CESIUM LOCK**, and the **MINOR** indicators should be off. In addition, the **CRITICAL** relay is activated, and the red **CRITICAL ALARM** LED remains on during initialization. Outputs are inhibited during the initialization period.
- After approximately 30 minutes, observe that the green **CESIUM LOCK** indicator is illuminated and the **INITIALIZATION** indicator turns off. Notify Datum's Service Department if the CRITICAL alarm is present after the initial 30 minute turn-on period. This indicates that the Datum PRS-50 has completed its warm-up and lock acquisition process. The telecom output signals turn on at this time.

2.4.1 Monitor.exe Software

The Datum PC DOS-based software provided for the communication interface is called MONITOR.EXE. Refer to Table 2.11-1 for the software part number.

2.4.1.1 Monitor.exe Installation and General Information

To install MONITOR.EXE, copy the program from the distribution diskette to a dedicated directory of your choice on your hard disk, move to that directory, and perform the following steps:

1) Ensure that the RS-232 port of the computer is connected to the rear panel RS-232 port (J4) of the PRS-50 via a null modem cable or a straight-thru cable with a null modem adapter. (Note that the front panel RS-232 connector is inactive without the TL1 Option. In addition, the row of dipswitches inside the front panel must all be switched to the ON position without the TL1 Option).

2) At the DOS prompt in the directory in which the MONITOR.EXE program is installed, type:

   MONITOR ‹‹xyz››

   where ‹‹**xyz**›› are command line parameters described below:

   ‹‹**x**›› is the computer's comm port, usually either **1** or **2**.

   ‹‹**y**›› is the baud rate which the PRS-50 is expecting, usually 2400 baud.

   6 = 9600 baud

   5 = 4800 baud

   4 = 2400 baud (default)

   ‹‹**z**›› is related to the processing speed of the computer and is selected to be **1**.

   The command line will typically be: **MONITOR 141**

3) When the main screen appears (sample screen shown in Figure 2.4-1), select the F8 key to open a dialog box. Enter the last five digits of the serial number from the ten-digit S/N number tag located inside the cesium module front-panel door. Press Enter to return to the main screen. Note that the V rate indicator at the upper left of the screen counts down to 1, and the data window in the upper left corner of the screens flashes with the data string download. The V rate poll interval default setting is 12 seconds. Next, the data appears in the 24 data windows, and is updated at the time interval shown. This poll interval may be changed with the F7 key, but depends on the baud rate and should be greater than or equal to the minimum poll interval shown:

   9600 -- 2 s

   4800 -- 3 s

   2400 -- 4 s

4) Press the F10 key for a HELP menu and list of all available commands for this program. Refer to Figure 2.4-2 for a help menu sample. Press ESC to return to the main screen. To exit the program and return to DOS, press the Q key.

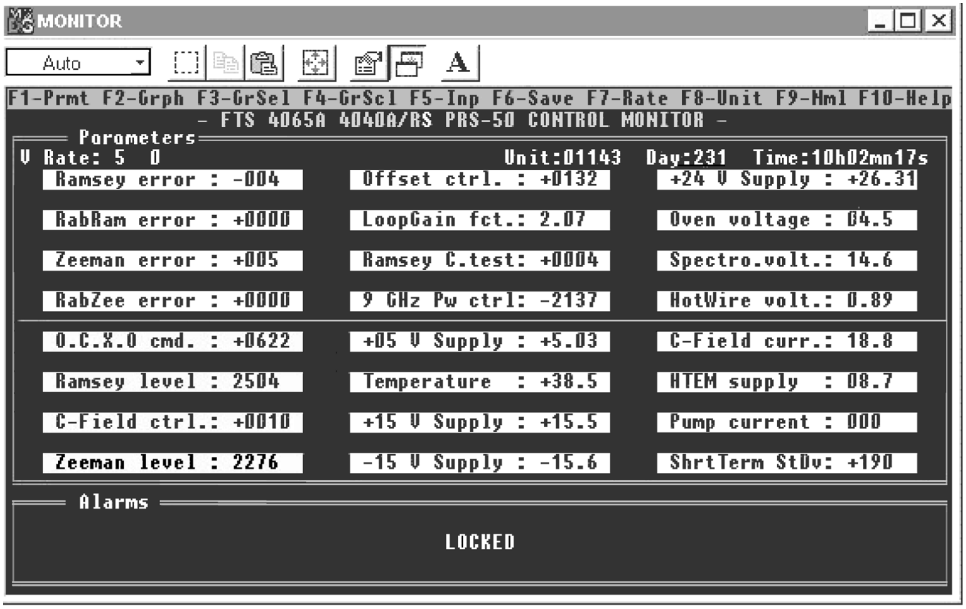
NOTE

The MONITOR.EXE main program screen displays a CRITICAL alarm until the unit comes out of warm-up. (Sample screen shown in Figure 2.4-1.

5) From the main screen, press F1 to open the control settings menu (See Figure 2.4-3) and move the cursor to Time/Date. Change the fields by entering a new number for the elapsed day count, the time of day (in hours, minutes and seconds), and press the ENTER key. Set the TTL square wave output frequency by moving the cursor to the Sqr. Out line and type in the desired frequency, and then press the Enter key (**Note:** Only 1, 5, or 10 MHz is selectable). No other functions on this screen require use.

2.4.1.2 Monitor.exe Screen Shots

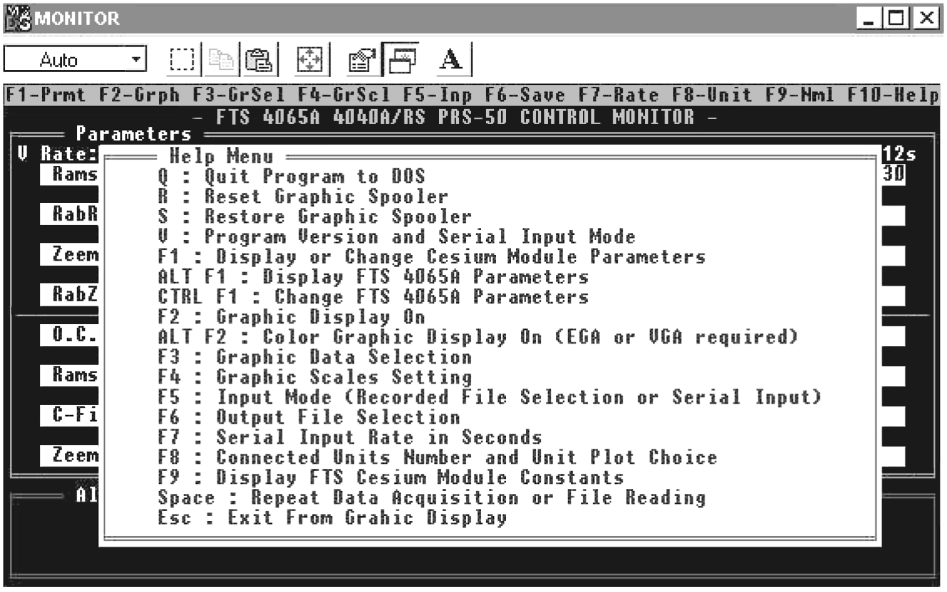
Figure 2.4-1: *Monitor.exe Main Screen*



prs00008

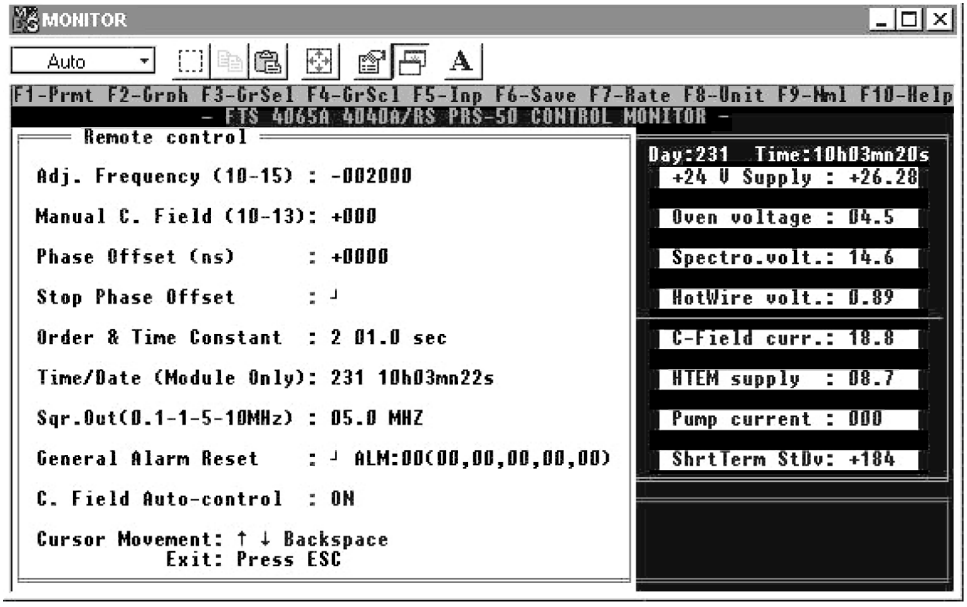
The main screen displays 24 parameters within the cesium instrument. The status of the instrument is displayed in the lower window: LOCKED, MAJOR ALARM, MINOR ALARM, INITIALIZATION.

Figure 2.4-2: *Monitor.exe Sample Help Menu*



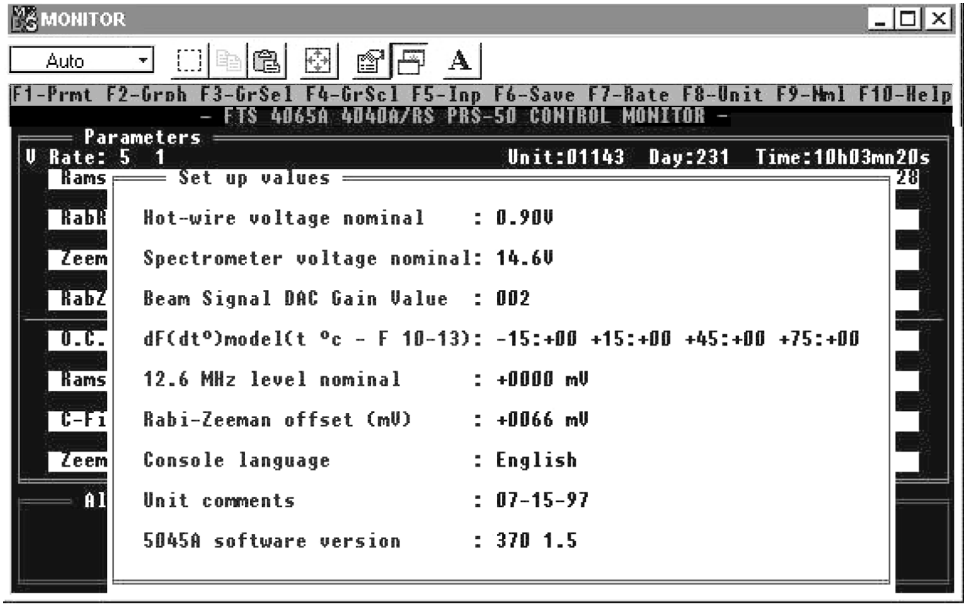
prs00009

Figure 2.4-3: *Monitor.exe Sample Control Settings Menu*



prs00010

Figure 2.4-4: *Monitor.exe Constants Settings Menu*



prs00011

Press *F9* to view the Constants settings menu. It is accessed primarily to view the beam signal DAC gain value. Over the life of the cesium tube, this value will increase in steps from 2 to 128 by factors of 2^n.

2.5 Turn-On Procedure (With TL1 Option)

- Ensure that the unit is properly grounded according to the site's grounding requirements. Refer to Section 1.6.3, Electrical Connections for details. Apply DC power to the **POWER INPUT A ,TB1** and **POWER INPUT B, TB3** on the rear panel of the PRS-50.
- Observe that the green **DC POWER** and amber **INITIALIZATION** indicators are illuminated. **FUSE A** and **FUSE B**, **CESIUM LOCK**, and the **MINOR** indicators should be off. In addition, the **CRITICAL** relay is activated, and the red **CRITICAL ALARM** LED remains on during initialization. Outputs are inhibited during the initialization period.
- After approximately 30 minutes, observe that the green **CESIUM LOCK** indicator is illuminated and the **INITIALIZATION** indicator turns off. Notify Datum's Service Department if the CRITICAL alarm is present after the initial 30 minute turn-on period. This indicates that the Datum PRS-50 has completed its warm-up and lock acquisition process. The telecom output signals turn on at this time.

NOTE

If the model PRS-50 has the TL1 Option installed, the amber MINOR ALARM LED will be illuminated until the SET-TIME operation described below has been completed.

2.5.1 TL1 Interface Software: Datum Instrument Monitor (DATUM IM)

The Datum PC software provided for the TL1 interface is a MS Windows compatible program called Datum Instrument Monitor (DATUM IM). Refer to Table 2.11-1 for the software part number.

To install DATUM IM, place the distribution diskette in drive A, run Window's file manager, log drive A, and double-click on SETUP.EXE. (Alternatively, click on FILE, then RUN from the Windows Program Manager, type A:\SETUP.EXE, and then click on OK.) The program will be automatically installed on your hard disk.

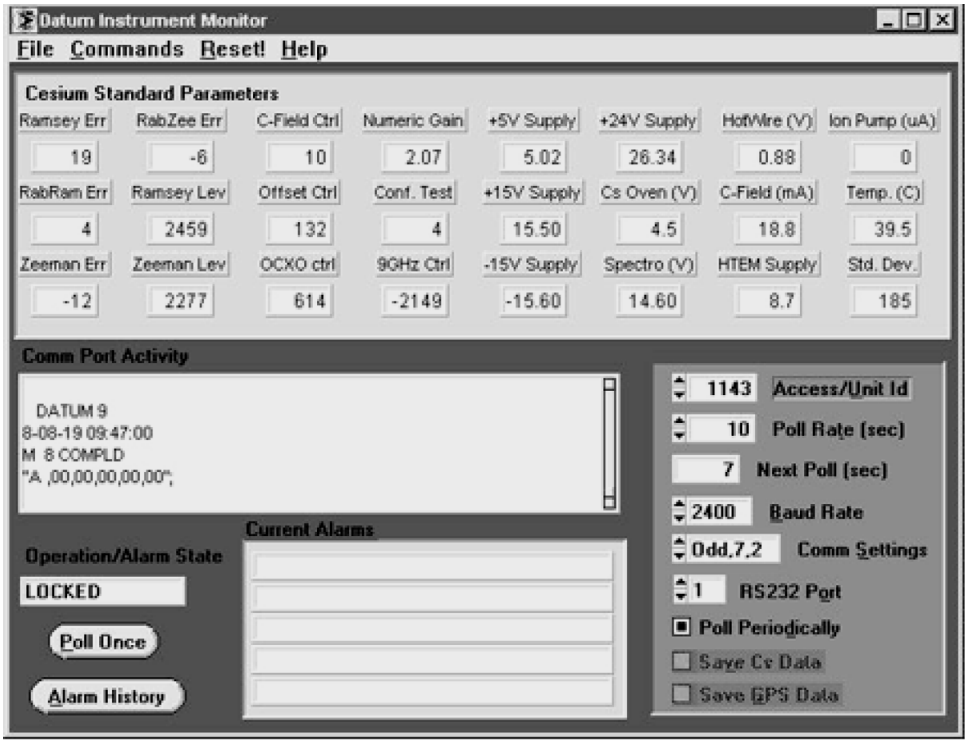
Ensure that the RS-232 port of the computer is connected to either the rear panel RS-232 port (J4) or the front panel RS-232 port (J2) of the PRS-50 via a null modem cable (provided with unit) or a straight-thru cable with a null modem adapter. (Note that the front panel RS-232 connector is active with the TL1 Option. In addition, the row of dipswitches inside the front panel must all be switched to the OFF position with the Option installed.)

To run DATUM IM, click on the PRS Communication group icon, and then click on the PRS Communication program icon. The default settings for the program are to operate from COM1 at 2400 baud with automatic polling enabled, and an access identifier <**AID**> of **01001**. Shortly after clicking on the program icon, the main screen, which is shown in Figure 2.5-1, will be displayed.

In order to communicate with the PRS-50, you must first change the Access/Unit Id to be the same as the serial number of the unit. Open the front panel of the PRS-50 to access the cesium module's serial number label. Use the last five digits of the serial number from the ten-digit S/N number tag located inside the cesium module front-panel door, (see Figure 2.9-1). In DATUM IM, click on the Access/Unit Id box and enter the last five digits of the serial number. Press ENTER.

Now to check for proper operation, select COMMANDS from the menu bar at the top of the screen and select RTRV-VARS. The monitor data will then be displayed in the 24 data boxes on the screen, as well as in the data window. The automatic polling sends the RTRV-VARS and RTRV-ALMS commands periodically at the settable poll rate. The software can be set to stop polling by clicking on the box marked Poll Periodically. If the default settings are not right for any particular set-up, they may be changed from the main screen.

Figure 2.5-1: *DATUM IM Main Screen*



prs00012

- The **SET-TIME** operation

  If the Datum Instrument Monitor (DATUM IM) software (Section 2.5.1) is being used, complete step 1. If the DATUM IM is not being used, skip to step 2.

  1) In the DATUM IM software, set the time in the PRS-50 by selecting COMMANDS from the menu bar at the top of the screen and then select SET-TIME. A box will appear with the message USE SYSTEM TIME, YES OR NO. Selecting YES will set the computer (system) time into the PRS-50. Selecting NO allows the user to set the time with the following format: YY, MM, DD, HH, MM, SS (year, month, day, hour, minutes, seconds).

     The turn-on procedure is now complete.

  2) Enter a **SET-TIME** command via the RS-232 communication port. (Refer to Section 2.8, for operating details and a list of all TL1 commands.)

  3) Using the syntax shown below, enter the **TID**. The **AID** value is the serial number of the cesium instrument package, which is the last five digits of the serial number from the ten-digit S/N number tag located inside of the cesium module front-panel door. The number should be entered in the format **IDxxxxx** where **xxxxx** is the serial number. For

the **CTAG** value, enter the number "**1**". The **TID** value is the name assigned to the unit by the user, and can be from 1 to 19 characters in length (no punctuation or spaces are permitted).

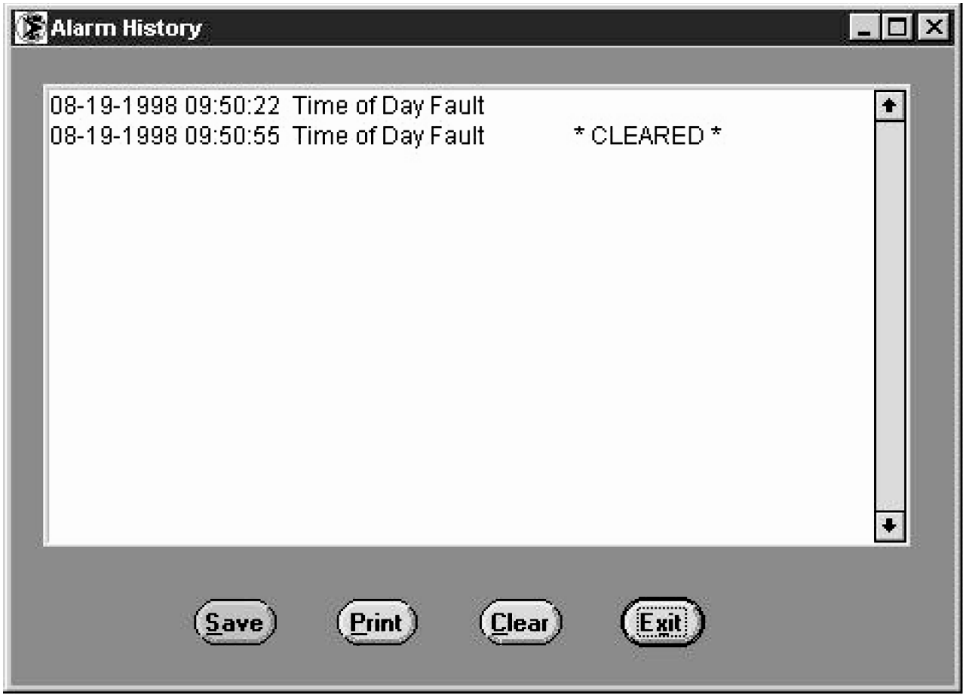
Syntax	**SET-TID::AID:CTAG::TID;**
Example	**SET-TID::ID09999:1::DATUM;**

Using the syntax shown below, set the date and time in the unit. The time begins incrementing when the "**;**" (semi-colon) is entered. Once the time has been set, verify that the amber **MINOR ALARM** LED is now OFF.

Syntax	**SET-TIME::AID:CTAG::yy,mm,dd,hh,mm,ss;**
Example	**SET-TIME::ID09999:1::99,12,30,11,44,30;**

Figure 2.5-2 is an example of the alarm history screen and can be viewed by clicking on the Alarm History button on the main screen.

Figure 2.5-2: *Datum Instrument Monitor Alarm History Screen*



2.6 Turn-Off and Restarting

To turn off the Datum PRS-50, remove EXT DC power or the fuses.

If power to the Datum PRS-50 is interrupted, restart the instrument using the turn-on steps above, as applicable. If the instrument is turned off for only a few minutes, frequency lock will be achieved in less than the specified warm-up time.

2.7 Operational Verification

After the Datum PRS-50 has been operating for its specified warm-up time the unit can be examined to verify proper operation if another frequency standard of equal or better performance is available.

Compare the relative phase movement of any of the output signals (the user-settable TTL output at 1, 5, or 10 MHZ or the telecom output) against a test signal derived from a frequency standard of equal or better performance. The relative phase movement of the two signals must be less than 36 ns/h or 864 ns/d. Typical performance is much better. The Stratum 1 worst case specification limit is 72 ns/h.

2.8 TL1 Compatible Commands, Responses, and Autonomous Messages

The commands, responses, and autonomous messages described in this section are PRS-50 functions that are formatted to meet the requirements of BELLCORE's Operations Application Messages -- Language for Operations Application Messages, TR-NWT-000831.

2.8.1 TL1 Command List

The PRS-50 command set follows the TL1 syntax, which is described in Appendix A. For example, the command to retrieve the PRS-50 alarm message is:

RTRV-ALMS:<TID>:<AID>:CTAG::;

The <**TID**> (target identifier) field is optional and may be omitted by just using two colons. The <**AID**> (access identifier) portion of the input command message consists of the two characters "**ID**" plus the five digit serial number of the unit, which is the last five digits of the serial number from the ten-digit S/N number tag located inside the cesium module front-panel door, e.g. **ID01001**. The serial number must correspond to the serial number of the cesium module inside the unit in order for the command to be recognized. The <**CTAG**> (correlation tag) portion of the input command message consists of a decimal number between **1** and **999999**, or an alpha-numeric up to six characters. It is issued by the command terminal and is returned in the response message as a way of correlating the command and its response. Finally, note that the dashes "-" and the colons "**:**" must be included in the command string, and the string is always terminated with a semi-colon ";". Refer to the information on TL1 format contained in Appendix A for details.

Table 2.8-1: TL1 Command List

Command	Description
RTRV-ALMS::<AID>:<CTAG>::;	Retrieve alarms message.
SET-AUXOUT::<AID>:<CTAG>::n;	Set aux. signal frequency: n={2, 3, or 4} representing 1, 5, and 10 MHZ.
SET-ALM-CUTOFF::<AID>:<CTAG>::;	Returns alarm relays to non-alarm state.
SET-CLRALM::ID:<CTAG>::;	Clears an alarm.
SET-CLR-EVENTLOG::<AID>:<CTAG>::;	Clears an event log.
SET-ECHO-ON::<AID>:<CTAG>::1;	Enables command echoing on the rear port.
SET-ECHO-OFF::<AID>:<CTAG>::1;	Disables command echoing on the rear port.
SET-ECHO-ON::<AID>:<CTAG>::2;	Enables command echoing on the front port.
SET-ECHO-OFF::<AID>:<CTAG>::2;	Disables command echoing on the front port.
SET-TID::<AID>:<CTAG>::<TID>;	Set unit target identifier to any string up to 19 characters.
SET-TIME::<AID>:<CTAG>:: YY,MM,DD,HH,MM,SS;	Set unit time and date (entire string must be entered).
SET-BAUD::<AID>:<CTAG>::n;	Set unit baud rate: n={12,24,48,96,192}, (actual baud = n*100; default is 2400).
SET-USER-COMM::<AID>:<CTAG>::n;	Set unit comm port parameters: N={0,1} 0 = None,8,1; 1 = Odd,7,2.
RTRV-EVENTLOG::<AID>:<CTAG>::;	Retrieve an event log.
RTRV-VARS::<AID>:<CTAG>::;	Retrieve variables message.
RTRV-CONS::<AID>:<CTAG>::;	Retrieve constants message
RTRV-FWVER::<AID>:<CTAG>::;	Retrieve firmware version number.
RTRV-HDR::<AID>:<CTAG>::;	Returns timestamp and target identifier.

2.8.2 Response Message Structure

The TL1 response message that corresponds to the TL1 input command is either a “command-completed response” or a “command-denied response,” as in the following examples:

“<blank line>”
“ **PRS-50 95-09-06 15:00:58**”
“**M 1032 COMPLD**”
“<text block>”
“**;**”

or

“<blank line>”
“ **PRS-50 95-09-06 15:00:58**”
“**M 1032 DENY**”
“**IICM**”
“**;**”

The **PRS-50**, **95-09-06**, and **15:00:58** in the examples represent the TID, Date, and Time from the Unit. The number **1032** above is the correlation tag originated in the command. The **DENY**

response is sent if for any reason, such as incorrect AID, the unit cannot perform the command. The **IICM** represents the error code returned indicating the reason for the deny. The optional <text block> response for a successful completion depends upon the input command having been executed. Three of the commands have a text block response which need some explanation, and these are detailed below. The **RTRV-FWVER** command has a text block response which is self-explanatory. The remaining commands have no text response.

Command	Example Response
RTRV-ALM	"<blank line> " " **PRS-50 95-09-06 15:00:58**" "**M 1032 COMPLD**" "**A ,00,00,00,00,00**" The text block response, "**A ,00,00,00,00,00**", is a comma delimited list of the alarm state code and the five most recent fault codes. The alarm state codes are two characters taking the form: **A^** = no alarm or lock (the carat "^" represents a space) ***^** = minor alarm ***C** = critical alarm

The two-digit numeric codes that follow represent the faults raised in the PRS-50 and are listed in Table 2.8-2.

Table 2.8-2: Fault Messages

(In retrieve alarm message and variables data string at positions 4 to 8)

Minor alarms		
08	oscillator control voltage	>90% < 95% (±4500 to 4750)
18	primary loop gain near limit	1 or 128
26	battery or fuse A fault	
27	battery or fuse B fault	
30	date and time-of-day not set	(causes critical alarm in earlier units)
32	Cesium Standard communication fault	
Critical alarms		
01	ramsey - background	>3 or <2
02	Rabi-ramsey error	>40
03	Rabi-zeeman error	>160
04	mass spec voltage drift	>±10% of memorized nominal
05	c-field current drift	<17 or >20
06	EM HV supply drift	<7 or >11
07	DAC input saturation	<5% or >95%
09	high internal temperature	>80°C (ambient + 15°C nominal)
10	not used	

Table 2.8-2: Fault Messages

11	12.6 MHZ power out of range	<-4500 or >-1000 (-3600±300 nominal)
12	+5 V supply	+5.0 ±0.4 V
13	+15 V supply	+15.5 ±1.5 V
14	-15 V supply	-15.5 ±1.5 V
15	EEPROM write error	
16	unit restart	
17	module memory configuration lost	
19	cesium oven excess heating	>10 V for longer than 45 min. 4 to 6 quiescent, >10 V warm-up
20	oscillator oven re-entered warm-up mode after warm-up	
21	ionizer supply error	>±0.16 V of memorized nominal value
22	ion pump current error	>240 µA, <10 nominal
23	24 V supply error	<20 or > 30 V (25 ± 2 V nominal)
24	DPM1, driver performance monitor	timing output faulted
25	DPM2, driver performance monitor	timing output faulted

RTRV-VARS "<blank line>"
" **PRS-50 95-09-06 15:00:58**"
"**M 1032 COMPLD**"

"**2,R+Z,00,00,00,00,00,00,+000,+001200,+25.3,10.1,+013,+0012,+008,+0036,-1318,2495,+0080,1677,+0822,3.28,+0001,-0408,+5.17,+35.5,+15.4,15.4,C,04.5,15.5,1.66,17.9,10.6,025,+107**"

The text block response (last line in the example above) is a comma-delimited, 36-position string of the operating parameters in the PRS-50. The parameters are listed and explained in Table 2.8-3 with the sample string included as example values.

Table 2.8-3: PRS-50 Operating Parameters

No.	Name	Description	Example
1	loop order	loop design, first or second order; default = 2	2
2	cesium servo mode	R+Z = oscillators locks to ramsey peak, c-field locks to zeeman peak R+T = oscillator locks to ramsey peak, c-field is constant	R+Z
3	4-state indicator	00 = LOCK (no faults) 01 = INITIALIZATION (CRITICAL for TL1) 10 = MINOR ALARM 11 = CRITICAL ALARM	00
4-8	5-place fault buffer	refer to table of faults, Table 2-4	00,00,00,00,00
9	c-field adjust	parts in 10-13 frequency adjustment using the cesium beam tube's C-field	+000
10	frequency adjust	parts in 10-15 frequency adjustment using the digital synthesizer	+001200
11	+25 V supply	voltage (V)	+25.3
12	loop time constant	1 to 999, in tenths of seconds	10.1
13	ramsey error	Represents the magnitude of the fine error signal on the main (ramsey) peak; <160 nominal.	+013
14	Rabi-ramsey error	Represents the magnitude of the coarse error signal on the main (Rabi) pedestal	+0012
15	zeeman error	Represents the magnitude of the fine error signal on the side (zeeman) peak; <160 nominal.	+008
16	Rabi-zeeman error	Represents the magnitude of the coarse error signal on the side (Rabi) pedestal	+0036
17	ocxo control	Represents the control voltage controlling the ovenized quartz crystal oscillator; ±500 at start of life, ±4900 at end-of-life.	-1318
18	Ramsey peak	Represents the magnitude of the main (Ramsey) peak; (2500 ± 200 nominal)	2495
19	C-field control	Represents the magnitude of the C-field control voltage (0 ± 400 nominal)	+0080
20	zeeman peak	Represents the magnitude of the first side (zeeman) peak; (Ramsey level - 200 ±200 nominal)	1677
21	Ramsey level offset	Represents the magnitude of the offset voltage added to the Ramsey response to center it within the range of the A/D converter; 60 to 200 nominal, proportional to loop gain factor.	2
22	software (numerical) gain	gain applied to the beam signal, 1 to 5; interacts with the hardware (DAC) gain	R+Z
23	Ramsey confidence	confirms central Ramsey symmetry by checking that the difference between adjacent valleys is small, <10 nominal.	00
24	microwave power	represents the magnitude of the microwave power applied to the cesium beam tube	-0408
25	+5 V power supply	voltage (V)	+5.17
26	internal temperature	°C	+35.5

Table 2.8-3: PRS-50 Operating Parameters

27	+15 V power supply	voltage (V)	+15.4
28	-15 V power supply	voltage (V)	-15.4
29	crystal oven state	F = cold, C = warm	C
30	cesium oven supply	voltage (V): 12 during warm-up, approximately 5 quiescent	04.5
31	mass spec supply	voltage (V) of the ionizer filament with respect to ground	15.5
32	ionizer supply	voltage (V) across the ionizer filament	1.66
33	C-field supply	current (µA) through the C-field winding	17.9
34	EM HV supply	voltage (V) applied to the primary of the electron multiplier high voltage supply (-2000 V)	10.6
35	IP HV supply	current (µA) being supplied by the ion pump high voltage supply (+3500 V)	025
36	standard deviation	a measure of the frequency stability of the unit 90 to 125 for an 12-year tube	+107

RTRV-CONS "<blank line>"

" **PRS-50 95-09-06 15:00:58**"
"**M 1032 COMPLD**"
"**14.0,0.87,002,+00,+00,+00,+00,+0345,-0045,05.0,GB,02/25/96,1.0**"

The text block response (last line in the example above) is a comma-delimited, 13-position list of constants that are memorized in the PRS-50, and are not changed except at the factory. The parameters are listed and explained in Table 2.8-4 with the sample string shown as examples. Some of the items listed are compared to monitored operating parameters, e.g. mass spec voltage and ionizer voltage. Item # 3 is actually a variable -- the primary loop gain.

Table 2.8-4: Constants String Data Template

No.	Name	Description	Example
1	mass spec voltage	Nominal level, memorized at factory	14.0
2	ionizer voltage	Nominal level, memorized at factory	0.87
3	Hardware gain	DAC value, 1 to 128, representing the gain on the beam signal; interacts with software (numerical) gain	002
4	f compensation	At -15°C, memorized at the factory	+00
5	f compensation	At +15°C, memorized at the factory	+00
6	f compensation	At +45°C, memorized at the factory	+00
7	f compensation	At +75°C, memorized at the factory	+00
8	12.6 MHZ level	Nominal level, memorized at factory	+0345
9	Zeeman offset	Asymmetry compensation, memorized at the factory	-0045
10	f, auxiliary output	1, 5, or 10 MHZ	05.0
11	Console mode language	GB(English) or FR(french)	GB
12	Comments	Text string for date of original factory acceptance test	02/25/96
13	Module ROM version	Ver 1.0	1.0

2.8.3 Autonomous Messages

When an internal fault is recognized by the PRS-50, it will proceed to transmit an autonomous message indicating the alarm condition. The message is sent to both the craft port on the front panel, J2, and the remote RS-232 port on the rear panel, J4. An example autonomous output string is:

“<blank line>”
“ PRS-50 95-09-06 15:00:58”
“*C 1 REPT ALM”
“02,07,00,00,00”
“;”

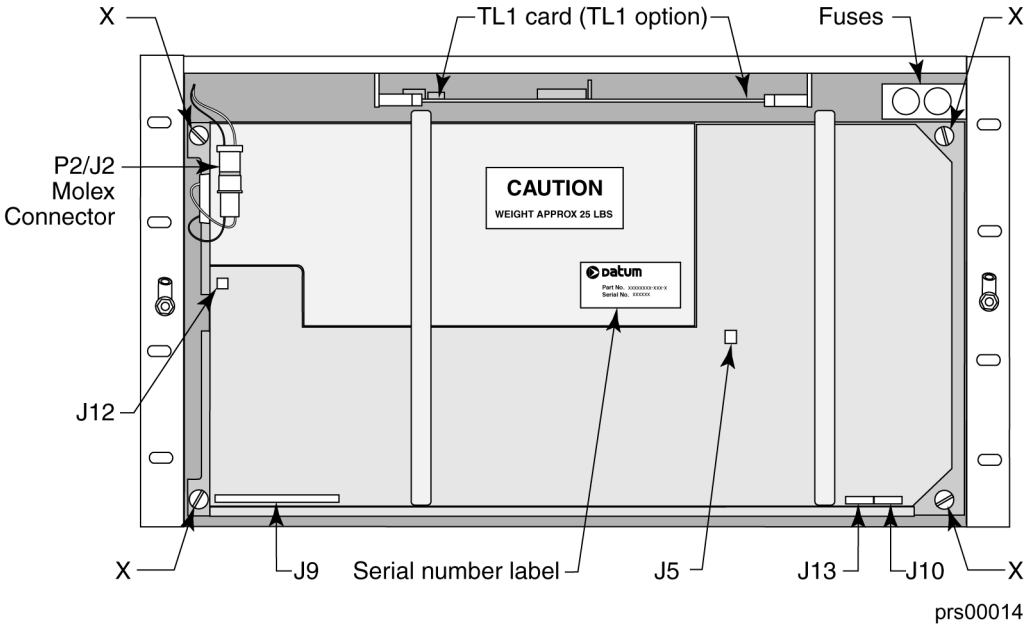
The <**almcde**> will take on the syntax: "***C**" or “*****^”, indicating critical alarm or minor alarm message, respectively. Major alarm “******” is not used. The number following is the autonomously generated correlation tag, <**atag**>, which will be a decimal number, sequential, and auto-incrementing with each new output. The <**text_block**> portion of the message will be the five, two-digit fault codes as listed in Table 2.8-2 above. Note that the output rate of this message is once every 10 seconds, and continues for as long as the alarm persists. The date-time stamp in the header reflects the first occurrence of the alarm. Once all alarms have cleared, a single autonomous message will be sent indicating all clear (<**text block**> of “**00,00,00,00,00**”).

2.9 Service

If the CRITICAL ALARM remains lit indicating a failure of the PRS-50, the instrument may be serviced by replacing the cesium module behind the front cover. Referring to Figure 2.9-1, do the following:

1) Remove external DC power
2) Open the front panel of the unit.
3) Remove the following connectors:
   - x2 SMB coaxial connectors -- **J5, J12**
   - x2 multi-pin connectors -- **J10, J13**
   - x1 ribbon cable connector -- **J9**
4) Loosen the four mounting screws, as shown, **X**.
5) Remove the DC power source to the 5045 by disconnecting the white Molex connector, which is located on the upper left-hand corner of the 5045 -- **P2/J2**.
6) Utilizing the handles provided, carefully remove the cesium module from the unit. TAKE CARE TO TAPE BACK CABLES DURING REMOVAL AND REPLACEMENT SO AS TO NOT DAMAGE THEM. IN ADDITION, BE CAREFUL NOT TO DROP THE CESIUM MODULE, AS IT WEIGHS 25 POUNDS.
7) Install the replacement cesium module, refastening and reconnecting the screws and cables removed above.
8) Close the front panel door, fastening the 2 retaining screws.
9) Apply DC power and wait for the specified warm-up time. This completes the service procedure. Note that any control and monitor software will require the use of a new serial number.

Figure 2.9-1: *PRS-50 Inside View for Servicing*



2.10 Maintenance

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

NOTE

Please retain the original packaging of the unit for re-shipping the product as needed. If the original packaging has been discarded, contact the Customer Service department at 1-512-721-4000 for assistance.

2.10.1 Preventive Maintenance

The PRS-50 unit requires no preventive maintenance. Care should be taken to insure the unit is not exposed to hazards such as direct sunlight, open windows, or extreme heat. Should the unit require cleaning, the exterior chassis may be wiped off using a soft cloth dampened with mild soapy water.

CAUTION

Under no circumstances should the interior chassis of the PRS-50 unit be allowed to come in contact with water.

CAUTION

Never attempt to vacuum the PRS-50 unit as this may cause an electromagnetic discharge and damage the circuitry.

2.10.2 Re-Ordering Information

Contact the sales office to re-order any subassembly or accessory or to obtain a current list of subassemblies, accessories, and item numbers (see Section 2.11). When you know what items you are ordering, supply the subassembly or accessory name and its item number alone with the purchase order number to our sales office.

2.10.3 Shipping Products Back to the Factory

Return all units in the original packaging. Products being returned for repair require no special preparation other than the standard packing procedure to protect the equipment during shipment described in Section 1.5. 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.

2.10.4 Returning Products Procedure

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

1) Call the Customer Service at 1-512-721-4000 to obtain a return authorization before returning the product for service.
2) Provide a description of the problem, product item number, serial number, and warranty expiration date.
3) Provide the return shipping information (customer field contact, address, telephone number, and so forth.)
4) Follow the guidelines described in these reference documents:
   - 1.5.1, HAZMAT Shipping Considerations
   - 1.5.2, Shipping Procedure
   - 1.5.3, Shipping Carriers
5) Ship the product to Datum, transportation prepaid and insured, with the Return Material Authorization (RMA) number and serial numbers clearly marked on the outside of the container to:

Datum, Inc.
15811 Vision Drive
Pflugerville, TX 78660

Attention: Service Department

2.11 Accessories

Table 2.11-1 is a list of accessories and their respective part numbers.

Table 2.11-1: Accessories

Reference Designator	Assembly Name	Part No.
ACCESSORIES		
Software	Control Monitor PC Application (DOS)	14181214-000-0
	Datum Instrument Monitor (TL1) PC Application (Windows)	14181478-000-0
RS-232 null modem cable	DB9 F/F, Crossover	805RS23-2001
Spare Fuse	3.15 Amp, 250 V, fast-acting, metric	552005-0007
RS-232 pass-through cable	DB25m/D9F, 6 ft.	805S925P6

3 Theory of Operation

This section provides a Theory of Operation for the PRS-50 which complements the functional description and offers a better understanding of the instrument's operation.

3.1 Introduction

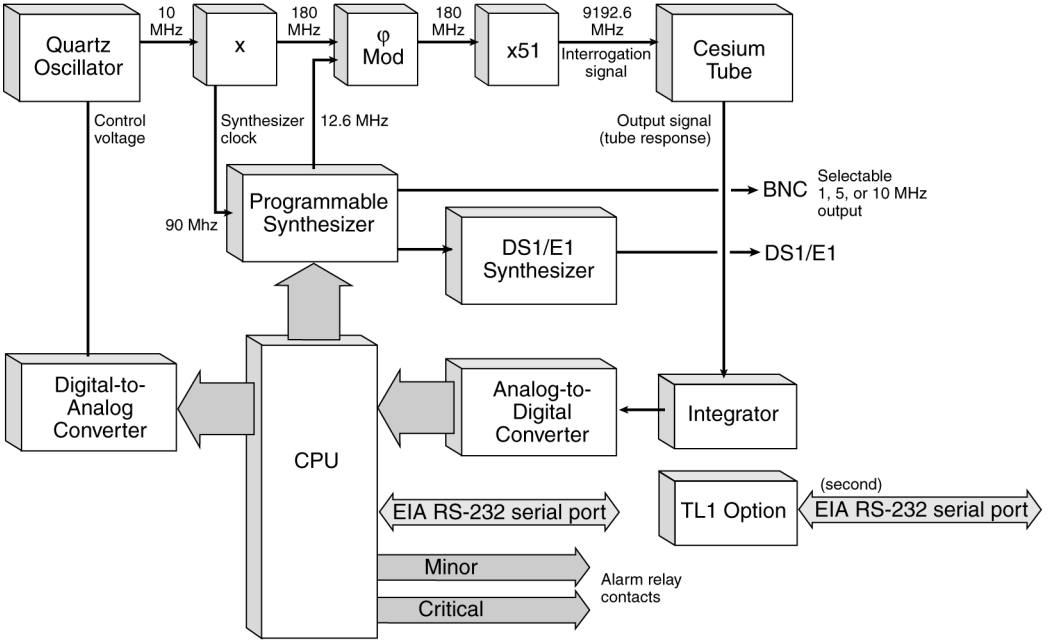
The Datum PRS-50 Cesium Frequency Standard generates signals that are:

- Accurate
- Spectrally pure
- Stable

Accuracy is obtained by comparing the output frequency of a quartz crystal oscillator to the atomic resonance of a beam of cesium atoms. **Spectral purity** (absence of all frequencies in the output signal except the fundamental frequency) is obtained by using a high performance quartz crystal oscillator to create the desired output signal. **Stability** (maintaining the specified frequency over a specified time interval) is derived from the invariant resonant frequency of cesium atoms.

The major components of the Datum PRS-50 are shown in Figure 3.1-1. The principle component of the Datum PRS-50 is the Cesium Frequency Standard Module (CFS). The CFS Module contains all the electronics to generate the required output signals, including the Telecom Synthesizer (DS1 or E1) and selectable TTL output (1, 5, or 10 MHz).

Figure 3.1-1: *PRS-50 Block Diagram (A1)*



The second major component of the PRS-50 is the Interface PCB Assembly which contains a processor/computer and four UART's for RS-232 communications. The theory of operation and a detailed description of the Cesium Module are given in the following sections.

3.2 Cesium Frequency Standard Module (CFS)

For years, cesium frequency sources have been constantly improved so as to satisfy the increasingly stringent specifications of time and frequency reference equipment. The availability of easy-to-operate instruments of reduced size and weight and of exceptional accuracy and stability provides the user with great flexibility in the application of cesium standards meeting the stringent requirements of navigation, communication and timing systems.

The cesium frequency module is an atomic frequency standard based on a hyperfine transition in the ground state of the cesium 133 atom. The frequency of this transition defines the international time unit: the second.

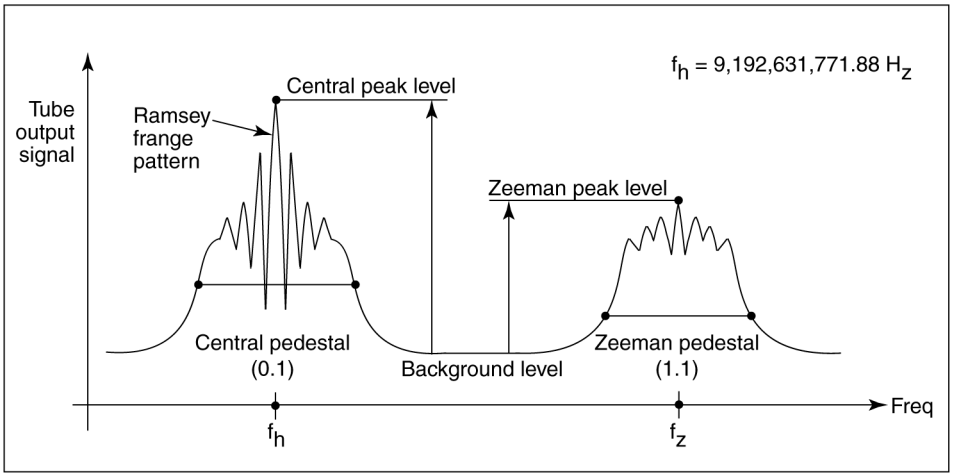
- A quartz oscillator whose frequency is locked to the hyperfine transition frequency (clock transition) of the cesium atom.
- A cesium atomic beam resonator (cesium tube).
- Control circuits, driven by the quartz oscillator frequency, delivering an interrogation signal. This signal is fed to the atomic resonator. The response of the resonator is a signal whose amplitude is maximum when the interrogation signal frequency is equal to the clock transition frequency.
- Servo loop circuits, fed by the tube output signal, which control the quartz oscillator frequency so that the interrogation frequency is locked to the clock transition.
- Power supplies.

A cesium tube can be thought of as a quadruple: when the frequency of the input signal scans the atomic transition, the output signal is a microcurrent of variable amplitude; the tube acts as a very narrow band-pass filter coupled to an amplitude detector.

When the frequency f of the microwave interrogation signal scans the clock frequency, the output signal of the cesium tube has the schematic behavior shown in Figure 3-3. A large resonance, called pedestal or Rabi resonance, is topped by interference fringes or Ramsey fringes (Ramsey pattern). The central fringe, or central line, provides the reference to which the interrogation signal frequency and, consequently, the quartz oscillator frequency are locked.

Moreover, the microwave spectrum displays six other resonances of similar structure, symmetrically disposed and regularly spaced about the central resonance. One of these is shown in Figure 3.2-1. The central frequency of this resonance pattern (Zeeman line) is linearly dependent on the magnetic field inside the cesium tube: by measuring this frequency it is possible to know and to stabilize the magnetic field inside the tube.

Figure 3.2-1: *Cesium Tube Output Signal vs. Microwave Input Signal Frequency*



prs00016

A programmable frequency synthesizer, controlled by a microprocessor and with a short response time, is used to periodically probe several characteristic points of the tube response. This probing is based on two principles:

First Principle: When two frequencies symmetrically disposed about f_r (central line) are alternately programmed, the tube output current switches between two levels; their difference is related to the offset of the quartz oscillator frequency from the resonant frequency.

Digitized, this difference is processed by the central unit and then fed back to the quartz oscillator.

Second Principle: As the servo loop time constant is much longer than the measuring cycle time, it is possible to periodically "steal" one measuring cycle which is then used to program other frequencies in order to check the different useful characteristic points of the tube response.

Thus, by using this flexible frequency synthesizing technique and the many possibilities offered by a microprocessor driven system, the time frequency standard performs, permanently and in real time operation, the following functions:

- Measurement and control of the central line centering through symmetrical testing of the pedestal.
- Measurement and control of the central line peak value relative to background and relative to the gain required in the cesium servo.
- Measurement and control of the magnetically dependent transitions to provide continuous feed-back to the frequency-determining C-field.

- Measurement and control of the microwave power applied to the tube, providing for optimum power over environment and time.

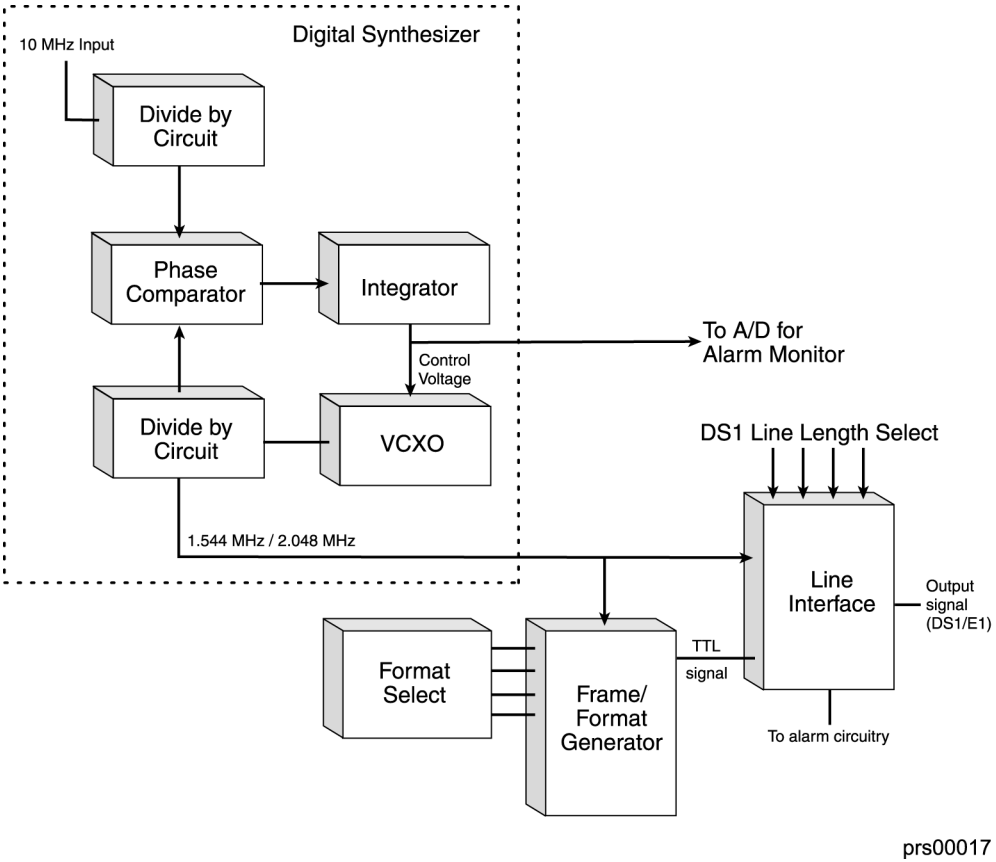
3.3 Telecom Synthesizer

The telecom synthesizer is integrated within the cesium module electronics. The synthesizer produces two outputs for either DS1 (1544 kbps) or E1 (2048 kbps) applications and consists of the following functional blocks:

- digital phase-lock synthesizer
- frame/format generator
- line interface devices
- alarm circuitry

Refer to the block diagram in Figure 3.3-1.

Figure 3.3-1: *Synthesizer Block Diagram*



The digital synthesizer section phase-locks a VCXO to a 10 MHz reference signal that is derived from the Cesium Frequency Module. Both signals are digitally divided, phase compared, and integrated to provide a control voltage to the VCXO.

The divider stage yields the clock signal which is distributed to the Format Generating Circuitry. The required formatted TTL output is provided by a Serial Receiver/Transmitter driven by the clock signal. The formatted data is applied to a Line Interface device.

The Line Interface device transforms the TTL signal (from the serial transmitter) into the appropriately shaped Alternating Mark Inverted (AMI) pulse. Alarm circuitry is provided by relay contacts that are brought to the PRS-50's rear panel ALARM connector.

The relays are activated by a loss of the 10 MHz reference input signal, a loss of the PLL phase-lock, a loss of Cesium lock, or a failure of the output driver circuit. The selection of DS1 or E1 application is set at the factory and is not to be changed in the field.

A TL1 Syntax

This section is provided for information only, to familiarize the user with the formal TL1 syntax, and how it is implemented in the PRS-50. Refer to Bellcore's Technical Reference TR-NWT-00831 for a complete description.

NOTE

Bellcore, or Bell Communications Research, is now Telcordia Technologies, Inc. The reference documents described in this section were originally published by Bellcore, but are now available from Telcordia Technologies, Inc.

A.1 Input Command Message Structure

The input command message structure is as follows:

VERB-MODIFIER:<TID>:<AID>:<CTAG>:<GB>:<PL>;

The "-" and the ":" must be included in the command string, and the string is always terminated with a ";". Unused fields are indicated by adjacent colons. Descriptions of TL1 command structure elements are shown in Table A.1-1.

Table A.1-1: TL1 Input Command Message Structure

Command	Description
VERB-MODIFIER ==	command verb with modifier
<TID> == <target identifier>	optional - up to 19 character name field
<AID> == <access identifier>	"ID" plus the 5-digit unit serial number, the last five digits of the serial number from the ten-digit S/N number tag located inside the cesium module front-panel door, e.g. ID01001
<CTAG> == <correlation tag>	decimal number or alpha-numeric up to six characters supplied by remote OS; to be returned in response message.
<GB> == <general block>	optional – not used by PRS-50
<PL> == <payload>	optional – not used by PRS-50

An example of a PRS-50 command to retrieve the alarm status is:

RTRV-ALM::ID01732:1032::;

A.2 Response Message Structure

The output response message structure that corresponds to the TL1 input command response is as follows (the ^ character indicates a space in the output):

<header><response identification>[<text block>] <terminator>

[The <text block> response depends upon the input command having been executed. Only four of the PRS-50 commands have text responses, and these are detailed in Section 2.8.2, Response Message Structure. The other commands have no text response.]

The <header> response takes the following form, where <sid> is the TID assigned to the unit:

<cr><lf><lf>^^^<sid>^<year>-<month>-<day>^<hrs>:<min>:<sec>

The <response identification> entry takes one of the forms below, with example responses given in quotes.

The TL1 response message that corresponds to the TL1 input command is either a “command-completed response” or a “command-denied response”. For a successfully completed input command (command-completed response), the format of the response will be:

<cr><lf>M^<CTAG>^COMPLD

An example of an optional text block response is:

“<blank line>”
“ **PRS-50 98-05-15 15:03:48**”
“**M 1032 COMPLD**”
“**A ,00,00,00,00,00**”
“**;**”

For an usuccessfully completed input command (command-denied response), the format of the response will be:

<cr><lf>M^<CTAG>^DENY

A four-character error code will be returned and will indicate the cause of the **DENY** response. An example of a text block response is:

“<blank line>”
“ **PRS-50 98-05-15 15:03:48**”
“**M 1032 DENY**”
“**IICM**”
“**;**”

The following errors codes in Table A.2-1 may be returned by a TL1 Network Element in the **DENY** response.

Table A.2-1: TL1 Error Codes

Code	Category	Description
IBEX	Input	Block, Extra
IBMS	Input	Block, Missing
IIAC	Input	Invalid Access Identifier
IICM	Input	Invalid Command
IICT	Input	Invalid Correlation Tag
IITA	Input	Invalid Target Identifier
IPNV	Input	Parameters Not Valid
ISCH	Input	Syntax Invalid Character
ISPC	Input	Syntax Punctuation

The <terminator> is always **<cr><lf>;**

A.3 Autonomous Messages

Autonomous messages are generated on the occurrence of events in the unit and have the following format:

<cr><lf><lf>
<header><cr><lf>
<almcde>^<atag>^REPT^ALM <cr><lf>
^^^**<text_block><cr><lf>**
;

The <header> portion of the autonomous message will be the same as that of the output message responses defined above. The <almcde> will take on the syntax: "***C**", or "*****^"; indicating Critical alarm or Minor Alarm message respectively. The autonomously generated correlation tag, <atag>, will be a decimal number. The number will be a sequential integer, auto-incrementing with each new output. The <text_block> portion of the message will be the same as that generated for the **RTRV-ALM** command, except that the <almcde> is not repeated. An example autonomous message is as follows:

"<blank line>"
" **PRS-50 98-05-15 15:03:48**"
"***C 1032 REPT ALM**"
"**02,07,00,00,00**"
"**;**"

Company:

Name: Title and Department:

Telephone: email:

Job Responsibility:

Please indicate your evaluation of this manual. Attach additional sheets with comments as needed.

1. How and when do you use this manual?

- ☐ Read entire manual before attempting task
- ☐ Read selected sections before attempting task
- ☐ Read while attempting task
- ☐ Attempt task first
- ☐ Read as last resort

2. How well is the manual's content *organized*? Please explain.

- ☐ **Excellent** — parallels product's operation, very usable
- ☐ **Good** — representative of the product's operation, usable
- ☐ **Average** — usable but can be improved
- ☐ **Fair** — not very usable, must be improved
- ☐ **Poor** — not usable, must be improved
- ☐ **No Opinion**

3. Is the manual's content *understandable* and *applicable* to the product's operation? Please explain.

Understandable	Applicable	
☐	☐	**Excellent** — very easy to understand, very applicable
☐	☐	**Good** — easy to understand, applicable
☐	☐	**Average** — applicable but some sections not easy to understand
☐	☐	**Fair** — not very understandable or applicable, must be improved
☐	☐	**Poor** — not understandable or applicable, must be improved
☐	☐	**No Opinion**

4. How well do the manual's *illustrations* convey product information? Please explain on a separate sheet.

- ☐ **Excellent** — very easy to understand, extremely usable
- ☐ **Good** — easy to understand, very usable
- ☐ **Average** — fairly easy to understand, usable
- ☐ **Fair** — not easy to understand, should be improved, not very usable
- ☐ **Poor** — cannot understand, must be improved, totally unusable
- ☐ **No Opinion**

5. Describe the *amount* of usable information in this manual including tables. Please explain.

- ☐ **Too much information** — not all required to perform task
- ☐ **Proper amount provided** — not too much or too little
- ☐ **Too little information** — needed additional information to perform task
- ☐ **No Opinion**

	Sections	Index
6. How well is information *cross-referenced* in the manual's individual section and index? Please explain.	☐	☐ **Excellent** — very easy to locate information, extremely usable
	☐	☐ **Good** — easy to locate information, very usable
	☐	☐ **Average** — fairly easy to locate information, usable
	☐	☐ **Fair** — not easy to locate information, should be improved, not very usable
	☐	☐ **Poor** — cannot locate information, must be improved, totally unusable
	☐	☐ **Did Not Use**
	☐	☐ **No Opinion**

7. How *useful* is the Glossary?

- ☐ **Useful**
- ☐ **Useful but not complete or accurate**
- ☐ **Not Useful**
- ☐ **Did Not Use**
- ☐ **No Opinion**

8. What is your *overall impression* of this manual? Please explain.

- ☐ **Excellent** — met all needs, extremely usable
- ☐ **Good** — met most of my needs, very usable
- ☐ **Average** — usable
- ☐ **Fair** — should be revised, not very usable
- ☐ **Poor** — must be revised, totally unusable
- ☐ **No Opinion**

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