PRS-50
Cesium Primary Reference Source

User Guide
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The contents of any amendments may affect operation and/or maintenance of the equipment.

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How to Use This Guide

Who Should Read This Guide

Chapter 1, General Information, is written for non-technical audiences who need general information about the product. Chapter 2, Operation, and subsequent chapters contain technical information about the product. Other chapters describe maintenance, and configuration instructions or details primarily intended for qualified maintenance personnel.

Structure of This Guide

This guide contains the following sections and appendixes:

Chapter, Title	Description
Chapter 1, General Information	Contains a general overview of the PRS-50.
Chapter 2, Operation	Describes the procedures for operating the product.
Chapter 3, Theory of Operation	Describes the theory of operation of the PRS-50..
Chapter 4, Service and Maintenance	Contains preventive maintenance and troubleshooting procedures for the product.
Appendix A, TL1 Syntax	Describes the TL1 syntax and commands available in the PRS-50.
Index	Provides references to individual topics within this guide.

Conventions Used in this Guide

This guide uses the following conventions:

- **Acronyms and Abbreviations** – Terms are spelled out the first time they appear in text. Thereafter, only the acronym or abbreviation is used.
- **Revision Control** – The title page lists the printing date and versions of the product this guide describes.
- **Typographical Conventions** – This guide uses the typographical conventions described in the table below.

When text appears this way...	... it means:
PRS-50 User Guide	The title of a document.
CRITICAL PORT-A J1	An operating mode, alarm state, status, or chassis label.
Select **File**, **Open**...	Click the Open option on the File menu.
Press **Enter**. Press **Print Scrn**.	A named keyboard key. The key name is shown as it appears on the keyboard. An explanation of the key's acronym or function immediately follows the first reference to the key, if required.
`OT-21` `Username:`	Text in a source file or a system prompt or other text that appears on a screen.
`ENGINE TDATA` `STATUS`	A command you enter at a system prompt or text you enter in response to a program prompt. You must enter commands for case-sensitive operating systems exactly as shown.
A *re-timing* application	A word or term being emphasized.
Datum ***does not*** recommend...	A word or term given special emphasis.

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 explained in the following examples.

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

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Note: All notes use this symbol. 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.

Related Documents and Information

Other helpful documents are listed below. See your Datum representative or sales office for a complete list of available documentation.

- Help files built into Datum's SynCraft application

Note: Datum offers a number of applicable training courses designed to enhance product usability. Contact your Datum representative or sales office for a complete list of courses and outlines.

Where to Find Answers to Product and Document Questions

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We appreciate your suggestions of ways to improve any part of this guide. Please make your suggestions on a copy of the affected page and include it with the reader comment form.

What's New In This Guide

This revision of the PRS-50 User's Guide has been reformatted to a larger size. Information has been moved within the book to help make information easier to find. It also contains the following new information:

- The How to Use This Guide section
- Appendix A, with a listing of the TL1 commands available in the PRS-50
- An Index to help locate information by topics

IN THIS CHAPTER:

Chapter 1 General Information

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

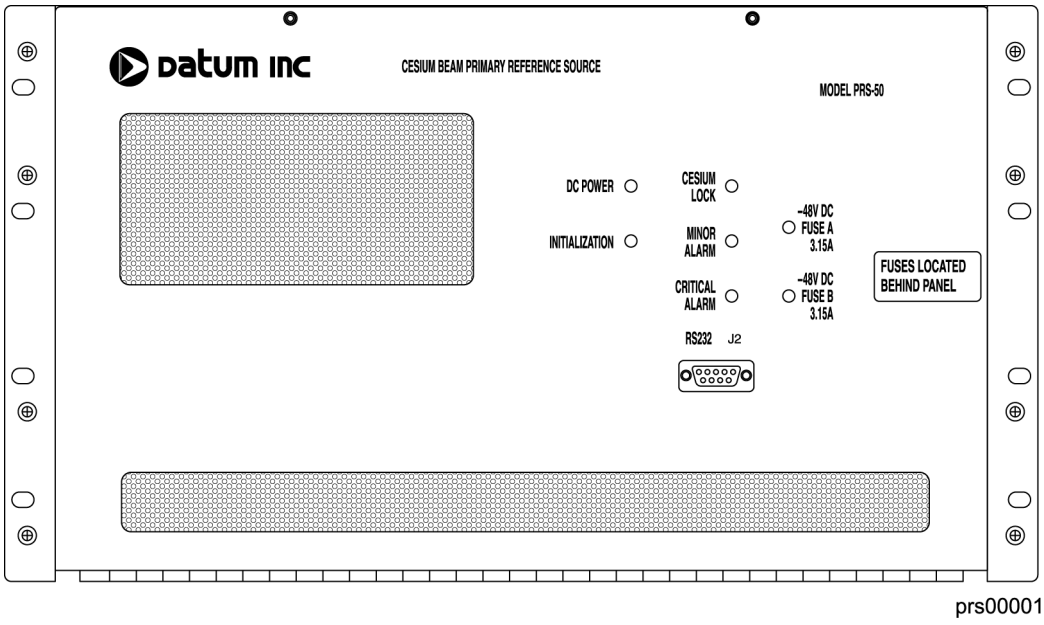


Figure 1-1 Front Panel of the PRS-50

1.1 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 an 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 4.1, 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. Chapter 3, Theory of Operation, provides more information on how the PRS-50 works.

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

1.2 Specifications

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

Table 1-1 Specifications for the PRS-50

Performance Characteristic	Specification
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 $_y$ ( )	

Table 1-1 Specifications for the PRS-50

Performance Characteristic	Specification
Averaging Time	
1 s	3.0×10^{-11}
10 s	1.3×10^{-11}
100 s	3.0×10^{-12}
1000 s	9.5×10^{-13}
10000 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 Kbps) selectable framing: SF(D4) or ESF with Stratum 1 Sync Status Message, 100Ω balanced symmetrical pair.
Format	Framed all ones, B8ZS/AMI
Connector	Rear panel, wire-wrap pins, x2
2048 Kbps	ITU-T Rec. 2048 Kbps (E1), 120Ω balanced symmetrical pair or 75Ω 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 (see Section A.5.2, Set Auxiliary Output)
Level	> 2.2 V into 50 Ω
Connector	Rear panel, BNC, x1
CONTROL & MONITOR SOFTWARE Refer to Chapter 2, Operation, for set-up details	
DOS environment (without TL1 Option)	Monitor.exe, see Monitor.exe Software in Chapter 2, Operation
Windows® 3.1x environment (with TL1 Option)	Datum IM, see Datum Instrument Monitor (DATUM IM) in Chapter 2, Operation
General	
Power Requirements	Dual DC inputs
Operating Voltage	–48 VDC nominal (–36 to –62 VDC)
Power (operating)	40 W

Table 1-1 Specifications for the PRS-50

Performance Characteristic	Specification
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 equivalent)
Craft (front panel)	Active only with TL1 Option
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 in (26.7 cm)
Width	18.125 in (64.0 cm)
Depth	10.1 in (25.7 cm)
Weight	36.5 lbs. (16.6 kg)
Mounting	Mounting ears provided for 19 in or 23 in 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. (61 m) below sea level to 12,000 ft. (3657 m) above sea level

1.3 Options

The PRS-50 is available with the options listed in Table 1-2. The options are further described in the following sections.

Table 1-2 Options Available for the PRS-50

Option	Part Number
DS1 outputs	25481271-001-0
DS1 outputs/TL1	25481271-002-0
E1 outputs	25481271-003-0
E1 outputs/TL1	25481271-004-0

1.3.1 DS1 Version

This version of the PRS-50 provides DS1 (1544 Kbps) 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 Synchronization Status Message is included in the output signals which identifies the source as a PRS (Stratum 1) source. See Table 1-1 for specifications.

1.3.2 E1 Version

This version of the PRS-50 provides ITU-T 2048 Kbps (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 1-1 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). 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 compatible with Windows 3.1x (or higher) 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 Appendix A, TL1 Syntax, from an ASCII terminal or terminal emulation software. The TL1 commands are compatible with Datum's SynCraft management application.

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 Vacuum in Cesium Beam Tube

If extended periods of storage (six months or longer) 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 Chapter 2, Operation, for the turn-on procedure.

Recommendation: To maintain the vacuum in the Cesium beam tube during extended storage periods, Datum recommends that you power up the PRS-50 for at least 30 minutes every six (or fewer) months.

1.4.2 Shelf Life of Cesium Beam Tube

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 four months.

1.5 Installing the PRS-50

This section provides unpacking instructions and installation procedures for the PRS-50 in addition to warnings, cautions, notes, and recommendations that pertain to the installation procedures. 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 1-1.

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.

1.5.1 Operating 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 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.

1.5.2 Rack-Mounting the PRS-50

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 (26.7 cm). The Datum PRS-50 is max. 10.1 inches (25.7 cm) deep and weighs approximately 36 lbs (16.4 kg).

The Datum PRS-50 is 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 1-2. The brackets may be mounted either flush with or 3.625 inches (9.2 cm) behind the Datum PRS-50 front panel.

Caution: To prevent overheating the unit, Datum recommends that you allow 1U (1.75 in/4.44 cm) above and below the unit for cooling. The PRS-50 is convection-cooled.

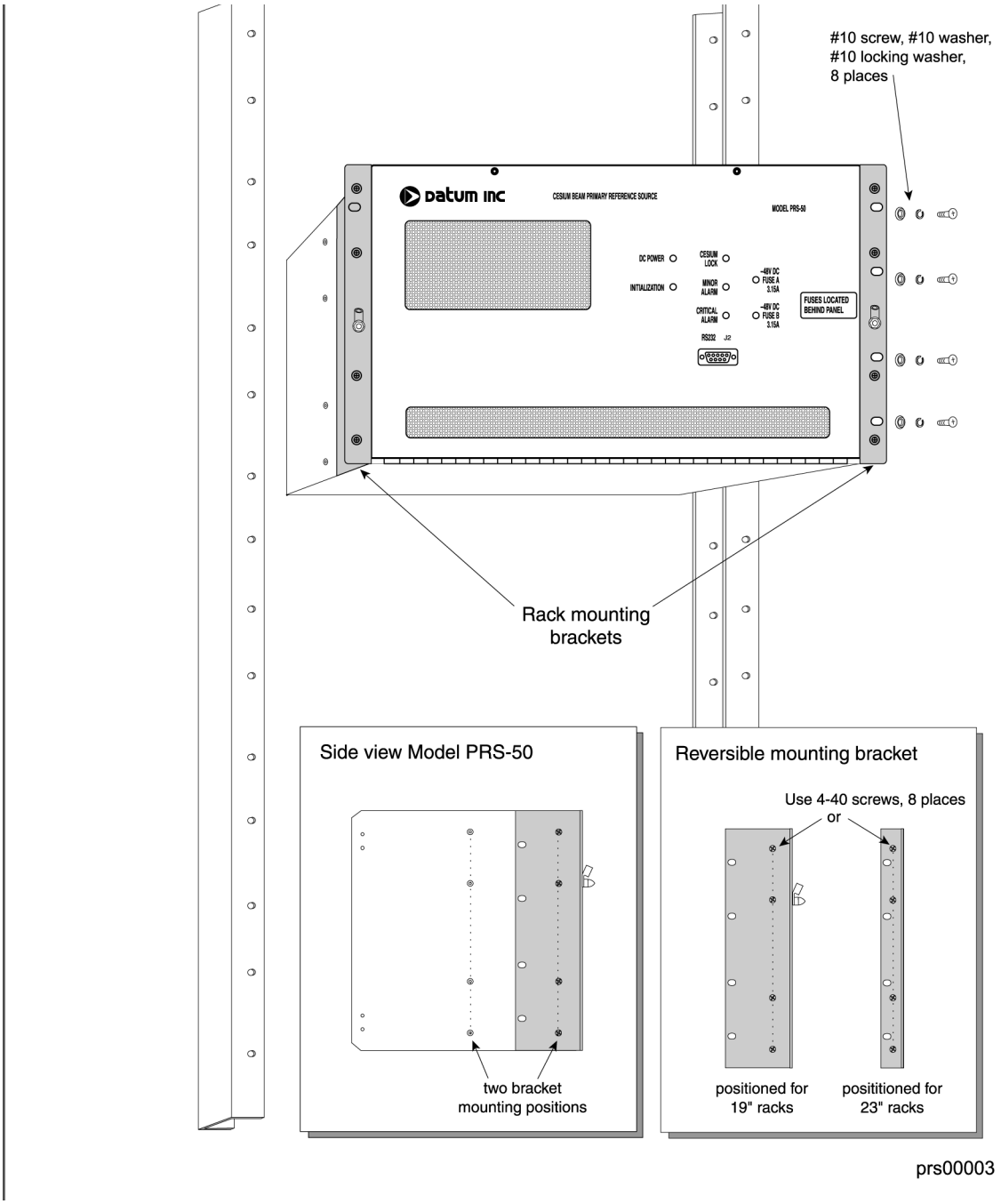


Figure 1-2 Rack Mounting the PRS-50

1.5.3 Electrical Connections

All permanent electrical connections are made at the rear panel. Refer to Figure 1-3 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.

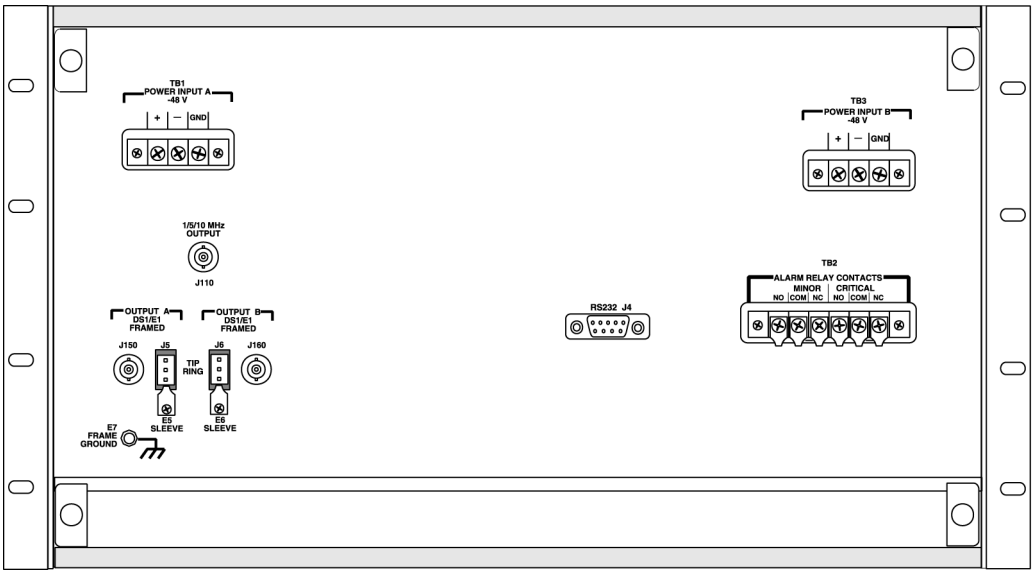


Figure 1-3 Rear Panel of the PRS-50 in the Standard Configuration

External DC Connections

The Datum PRS-50 is powered from dual external DC sources. Refer to Table 1-1 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.

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 1-4 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.

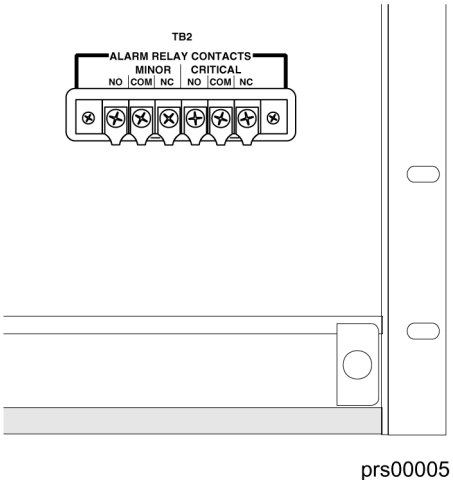


Figure 1-4 Alarm Closure Terminal Block

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 1-3. 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 Chapter 2, Operation.

Table 1-3 Pinouts of the RS-232 Connectors

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

Table 1-3 Pinouts of the RS-232 Connectors (Continued)

J2 Front Panel (Craft)		J4 Rear Panel (Remote)	
5	GND	5	GND
1	DCD	1	DCD
4	DTR	4	DTR

1.5.4 Setting Jumpers 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 1-5. Refer to the labels on the inside front panel of the unit for the proper jumpers for framing and line compensation. These settings are also described below in Table 1-5 through Table 1-8.

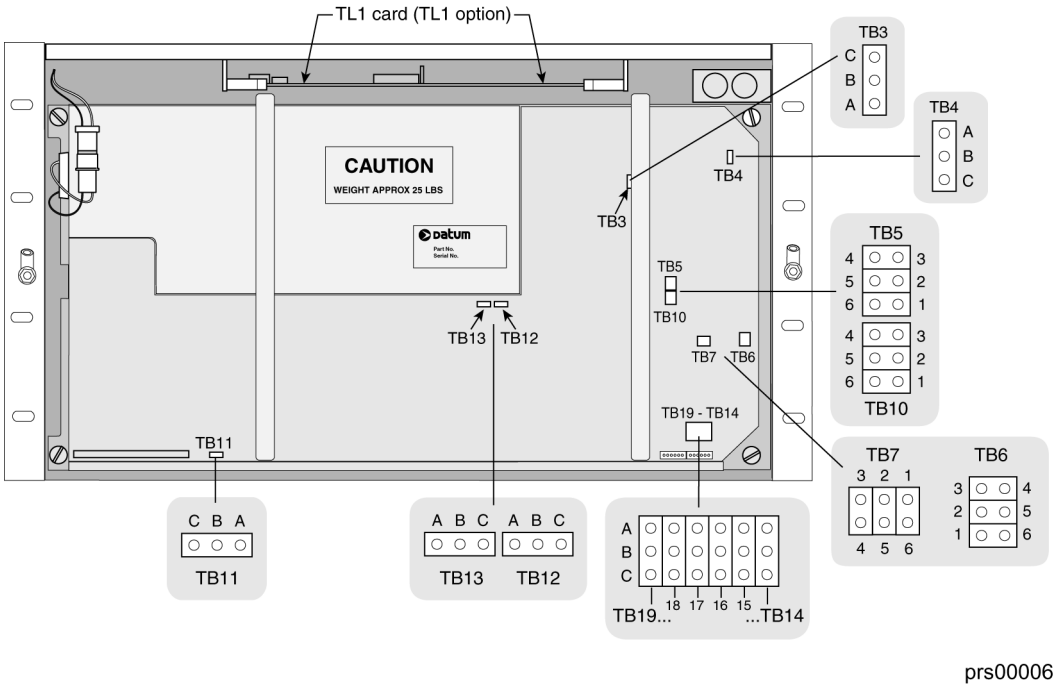


Figure 1-5 Location of Terminal Blocks

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. The output framing on TB-5 and TB-10 *must* be set the same. See Table 1-4.

Table 1-4 Framing and Frequency Jumper Settings

Desired Format	TB-5 and TB-10 Jumper Settings
PRS-50 Units with DS1 Outputs	
D4 (superframe)	2-5
ESF (extended superframe) SSM-enabled	3-4 (default)
PRS-50 Units with E1 Outputs	
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 1-5.

Table 1-5 TB-4 Jumper Settings

PRS-50 with:	TB-4 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.

Table 1-6 Other Jumper Settings

Jumper	Setting
TB-2	Shunt installed
TB-3[1]	A-B
TB-9[1]	None installed
TB-11 (RS-232 handshake on)	B-C
TB-12	A-B
TB-13	A-B

Note:
[1] May not be available on all versions of the PRS-50.

Line Compensation Jumper Settings

Line compensation is selected on jumper blocks TB6 (CH1) and TB7 (CH2). The factory default DS1 output is the shortest length, 0 to 133 feet. Refer to Table 1-7 and verify that the jumpers are set to the correct position for the length and type of cable being used for the outputs.

Table 1-7 Line Compensation Settings

TB-6 and TB-7 Jumper Locations			Output Cable Length (feet)	Cable Types
1-6	2-5	3-4		
PRS-50 Units with DS1 Outputs				
		X	0 – 220	MAT and ICOT
	X	X	220 – 440	
X		X	440 – 665	
		X	0 – 133 (default)	ABAM and PIC
X	X		133 – 266	
	X		266 – 399	
X			399 – 533	
(no jumpers)			533 – 655	
PRS-50 Units with E1 Outputs				
X	X	X	All	All

Note:
X indicates a jumper is installed in this position.

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. To select the desired output type, set the jumpers on TB-14 through TB-19 as shown in Table 1-8.

Table 1-8 Jumper Settings for Output Timing Signal

Connector Type	Channel 1			Channel 2		
	TB-14	TB-15	TB-16	TB-17	TB-18	TB-19
Balanced (Wire-wrap)	B-C	A-B	A-B	B-C	A-B	A-B
Unbalanced (BNC)	A-B	B-C	B-C	A-B	B-C	B-C

IN THIS CHAPTER:

Chapter 2 Operation

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

2.1 General Information

To turn on the Datum PRS-50 and obtain the specified output signals, simply connect the A and B power; no other user actions are required. Applying DC power initiates the warm-up and automatic lock acquisition sequence. Refer to Figure 1-1 for an illustration of the Datum PRS-50 indicators. Table 2-1 describes the front panel indicators.

Table 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 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.

Table 2-1 Front Panel Indicators (Continued)

Indicator name	Description
DC POWER	Turns green when DC power is present
-48 VDC FUSES A and B	Turns red when internal fuse is blown

Note: CRITICAL and MINOR alarms are listed in Table A-3. CRITICAL alarms mute all outputs.

2.2 Using the RS-232 Ports

The PRS-50 is controlled or monitored via the RS-232 ports. You communicate with the PRS-50 using either Datum software or TL1 (Transaction Language 1) commands. The Datum software, MONITOR.EXE (DOS) and the demonstration Datum Instrument Monitor (DATUM IM) (Windows), are described in the Monitor.exe Software and Datum Instrument Monitor (DATUM IM) sections.

The TL1 Option is a plug-in printed circuit board located behind the front panel. With the TL1 Option, the PRS-50 may be accessed directly from either the Datum software (DATUM IM), from an ASCII interface (a terminal program such as HyperTerminal or ProComm Plus, etc.) or using Datum's SynCraft network management software. Appendix A, TL1 Syntax, contains the ASCII interface and TL1 command list.

Table 2-2 RS-232 Interface Options

	Without TL1 option	With TL1 option
Ports available	J4	J2 and J4
DIP settings	All On	All Off
PC software	MONITOR.EXE (DOS)	DATUM IM (Windows) or SynCraft
Port parameters	2400 baud 7 data bits 2 stop bits Odd parity	9600 baud 8 data bits 1 stop bit No parity

RS-232 Communications Port Parameters

The default RS-232 communications port parameters are listed in Table 2-2. These settings may be changed by the user (see Section A.5.10, Set User Communication); the new settings are saved in non-volatile memory and are 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.

SynCraft

The PRS-50 can also be controlled using Datum's network control application SynCraft. Refer to the SynCraft on-line help system for details on setting up and controlling the PRS-50 using this application.

2.3 Turn-On Procedure (Without TL1 Option)

- Ensure that the unit is properly grounded according to the site's grounding requirements. Refer to Section 1.5.3, Electrical Connections, for details. Apply DC power to the POWER INPUT A, TB1 and POWER INPUT B, TB3 terminals on the rear panel of the PRS-50.
- Observe that the green DC POWER and amber INITIALIZATION indicators are lit. FUSE A and FUSE B, CESIUM LOCK, and the MINOR indicators should be off. The CRITICAL relay is activated, the red CRITICAL ALARM indicator is lit, and outputs are inhibited during the initialization period.
- After approximately 30 minutes, observe that the green CESIUM LOCK indicator is lit and the INITIALIZATION indicator turns off. This indicates that the Datum PRS-50 has completed the warm-up and lock acquisition process. The outputs turn on at this time.

  Notify Datum's Service Department if the CRITICAL alarm is present after the initial 30-minute warm-up period.

Monitor.exe Software

MONITOR.EXE is Datum's DOS-based application for communicating with the PRS-50 without the TL1 option.

Monitor.exe Installation and General Information

To install MONITOR.EXE:

1. Copy the program from the distribution diskette to a dedicated directory of your choice on the computer hard disk.

2. Connect the RS-232 port of the computer to J4 on the rear panel of the PRS-50 using a null modem cable (or a straight-through cable with a null modem adapter).

Note: The front panel RS-232 connector is active only when the TL1 Option is installed.

---

3. Ensure that the row of dipswitches inside the front panel is in the ON position

4. At the DOS prompt in the directory in which the MONITOR.exe program is installed, type **`MONITOR xyz`**, then press **Enter**, where `xyz` are the command line parameters described below:

   `x` is the computer's comm port, usually either 1 or 2

   `y` is the baud rate expected by the PRS-50, usually 2400 baud
   6 = 9600 baud
   5 = 4800 baud
   4 = 2400 baud (default)

   `z` is related to the processing speed of the computer and should be set to 1.

   The command line is typically `MONITOR 141`

5. Press F8 when the main screen appears (as shown in Figure 2-1). A dialog box appears.

6. Enter the last five digits of the ten-digit serial number tag located inside the cesium module front-panel door. Press **Enter** to return to the main screen.

Note: The MONITOR.EXE main screen displays a CRITICAL alarm until the unit completes warm-up.

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. To change the poll interval, press F7; the value depends on the baud rate and should be greater than or equal to the minimum poll interval shown:

9600 baud – 2 s
4800 baud – 3 s
2400 baud – 4 s

Press F10 to display a HELP menu and list of all available commands for this program. Refer to Figure 2-2 for a help menu sample. Press **Esc** to return to the main screen.

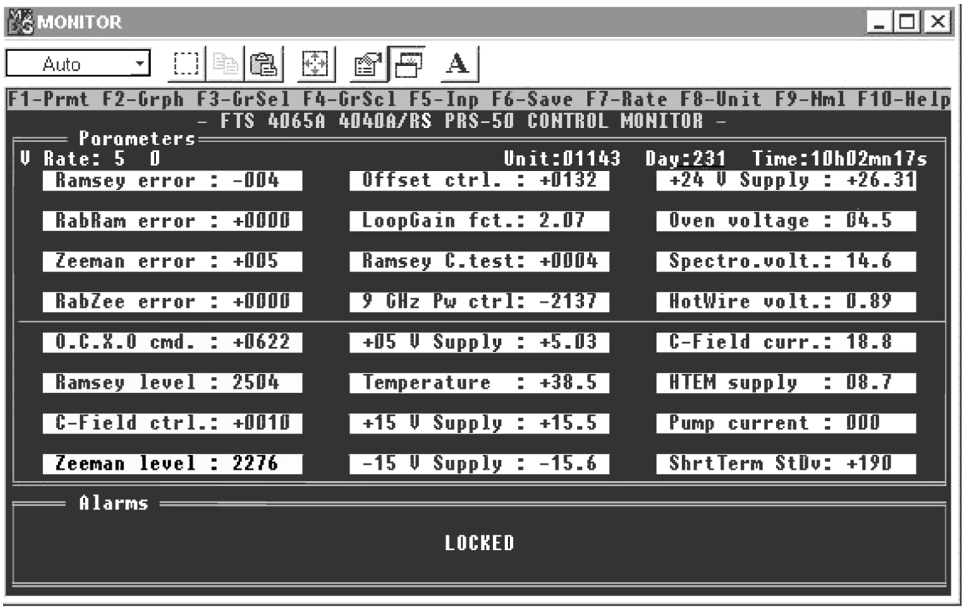
7. To exit the program and return to DOS, type **Q** and press **Enter**.

8. Press F1 to open the Control Settings window (Figure 2-3) and then 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 **Enter**.

9. 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 **Enter** (Note: Only 1, 5, or 10 MHz is selectable). No other functions on this screen require changes. Press **Esc** to return to the main screen.

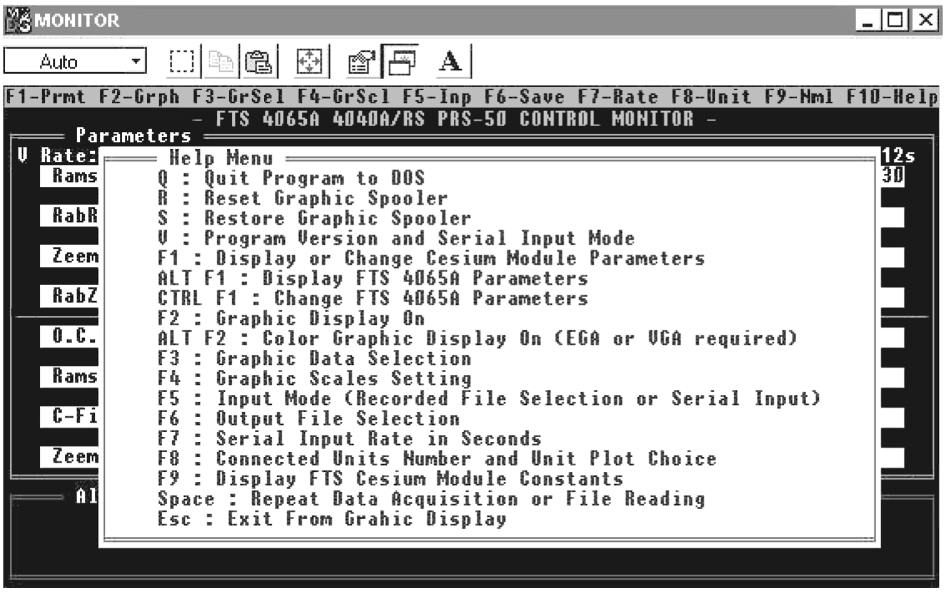
Monitor.exe Screen Shots

The main screen, shown in Figure 2-1, displays 24 parameters within the cesium instrument. The status of the instrument is displayed in the lower window: LOCKED, MAJOR ALARM, MINOR ALARM, INITIALIZATION.



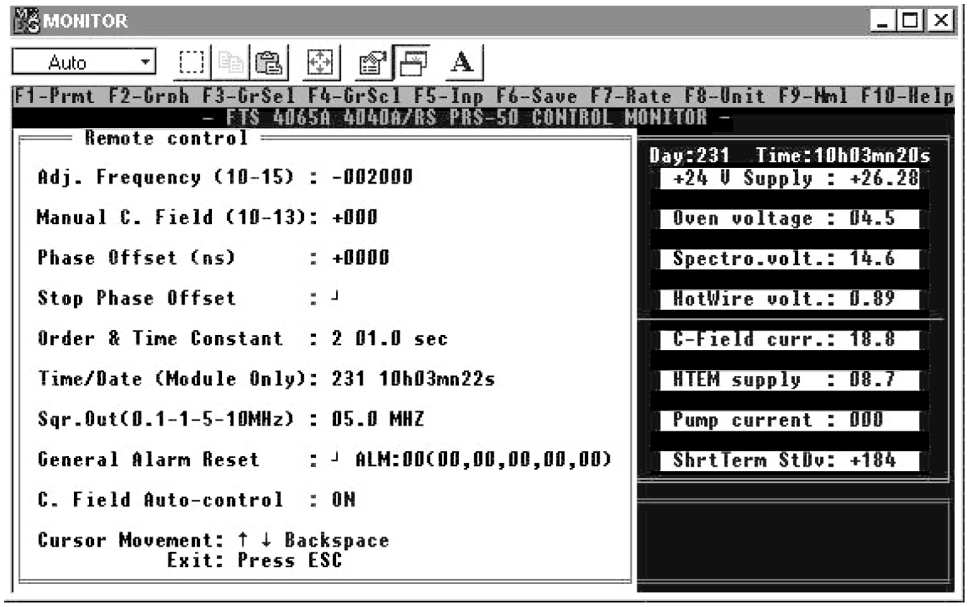
prs00008

Figure 2-1 Main Screen of MONITOR.EXE Program



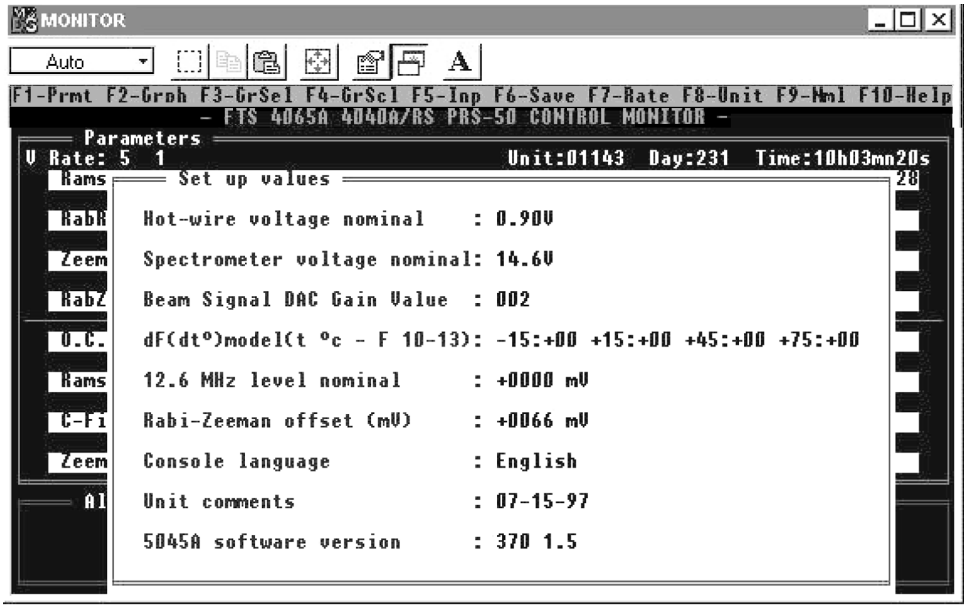
prs00009

Figure 2-2 Sample Help Menu



prs00010

Figure 2-3 Sample Control Settings Menu



prs00011

Figure 2-4 Constants Settings Menu

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 increases from 2 to 128 in steps of 2^n.

2.4 Turn-On Procedure (With TL1 Option)

- Ensure that the unit is properly grounded according to the site's grounding requirements. Refer to Section 1.5.3, Electrical Connections for details. Apply DC power to 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 lit. FUSE A and FUSE B, CESIUM LOCK, and the MINOR indicators should be off. The CRITICAL relay is activated, the red CRITICAL ALARM indicator is lit, and outputs are inhibited during the initialization period.
- After approximately 30 minutes, observe that the green CESIUM LOCK indicator is lit and the INITIALIZATION indicator turns off. This indicates that the Datum PRS-50 has completed the warm-up and lock acquisition process. The outputs turn on at this time.

  Notify Datum's Service Department if the CRITICAL alarm is present after the initial 30-minute warm-up period.

Note: If the PRS-50 has the TL1 Option installed, the amber MINOR alarm indicator is lit until the SET-TIME operation described below has been completed.

Datum Instrument Monitor (DATUM IM)

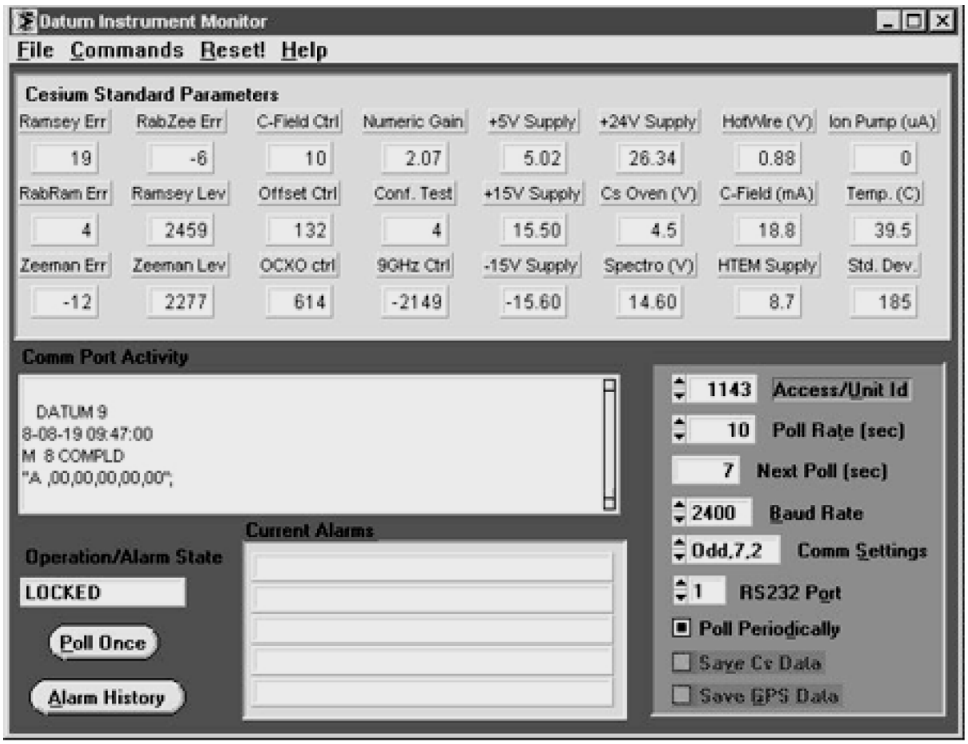
The Datum PC demonstration software provided for use with the TL1 interface is a Windows-compatible program called Datum Instrument Monitor (DATUM IM).

To install DATUM IM, place the distribution diskette in drive A, run Windows Explorer, select drive A, and double-click on SETUP.EXE. (Alternatively, select Start, select Run, type A:\SETUP.EXE, and then click OK.) Follow the on-screen instructions. The program is installed on the computer's 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-through cable with a null modem adapter.

Note: The front panel RS-232 connector is active only when the TL1 Option is installed.

To run DATUM IM, click the PRS Communication group icon, and then click the PRS Communication program icon. The default settings for the program are to operate from the PCs COM1 port at 2400 baud, 7 data bits, 2 stop bits, odd parity with automatic polling enabled, and an access identifier <aid> of 01001. After you click the program icon, the main screen appears, as shown in Figure 2-5.



prs00012

Figure 2-5 Main Screen of the Datum IM Program

To communicate with the PRS-50, you must change three items:

- Set the Access/Unit Id to 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 ten-digit serial number tag. In DATUM IM, click on the Access/Unit Id box and enter the last five digits of the serial number.
- Set the Baud Rate to 9600
- Set the Comm Settings to None, 8, 1

To check for proper operation, select COMMANDS, RTRV-VARS. The monitor data appears 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 user-defined poll rate. The software can be set to stop polling by clicking Poll Periodically. If the default settings are not right for any particular set-up, they may be changed from the main screen.

If you are using the Datum Instrument Monitor (DATUM IM) software, start the procedure at Step 1. If you are not using the DATUM IM software, start the procedure at 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 appears with the message USE SYSTEM TIME, YES OR NO. Selecting YES loads the computer (system) time into the PRS-50. Selecting NO allows the user to enter 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 the correct time using the SET-TIME command (refer to Section A.5.9, Set Time, for details). The time begins incrementing when the ";" (semi-colon) is entered. Once the time has been set, verify that the amber MINOR alarm indicator is OFF.

3. Enter the Target Identifier <tid> using the SET-TID command (refer to Section A.5.8, Set Target Identifier, for details).

   Figure 2-6 is an example of the alarm history screen. To display the Alarm History, click **Alarm History** on the main screen.

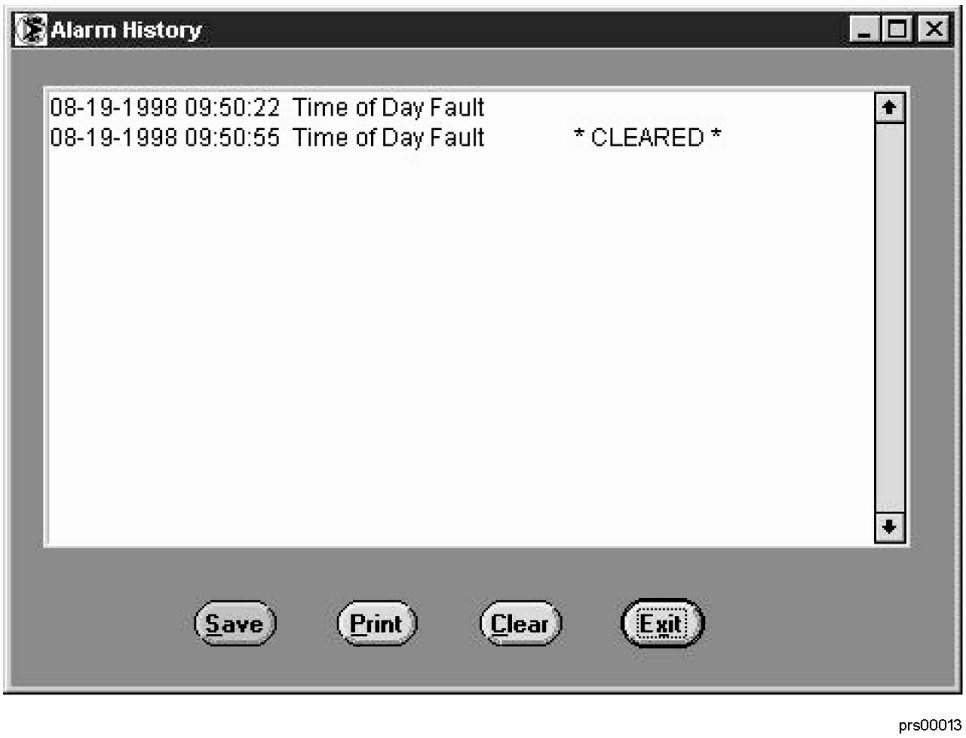


Figure 2-6 Alarm History Screen

2.5 Turn-Off and Restarting

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

If power to the PRS-50 is interrupted, restart the instrument using the turn-on procedure in either Section 2.3, Turn-On Procedure (Without TL1 Option), or Section 2.4, Turn-On Procedure (With TL1 Option), as applicable. If the PRS-50 is turned off for only a few minutes, frequency lock will be achieved in less than the specified warm-up time.

2.6 Verifying Operation

After the PRS-50 has been operating for its specified warm-up time, you can verify proper operation using another frequency standard of equal or better performance.

Compare the relative phase movement of any of the output signals (the user-defined 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.

IN THIS CHAPTER:

Chapter 3 Theory of Operation

This chapter describes the Theory of Operation for the PRS-50, complementing the functional description and offering a better understanding of the instrument's operation.

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. The principle component of the Datum PRS-50 is the Cesium Frequency Standard (CFS) Module. 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).

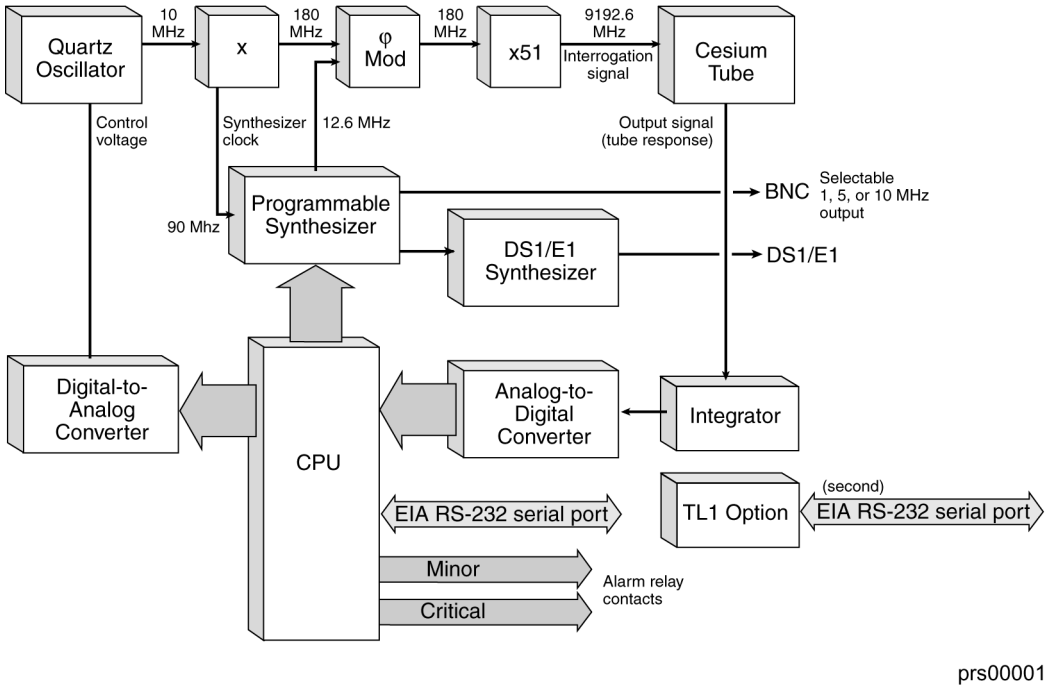


Figure 3-1 Block Diagram of the PRS-50

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.

Cesium Frequency Standard (CFS) Module

For years, cesium frequency sources have been constantly improved to meet 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 CSF 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. The CFS Module contains:

- 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 that deliver an interrogation signal which 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 3-2. A large resonance, called the 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. 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.

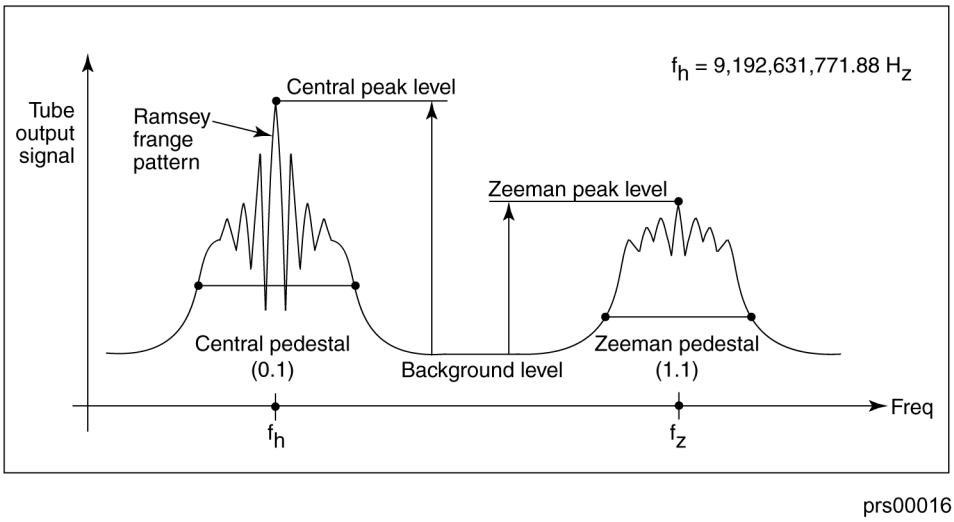


Figure 3-2 Cesium Tube Output Signal vs. Microwave Input Signal Frequency

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.

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

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.

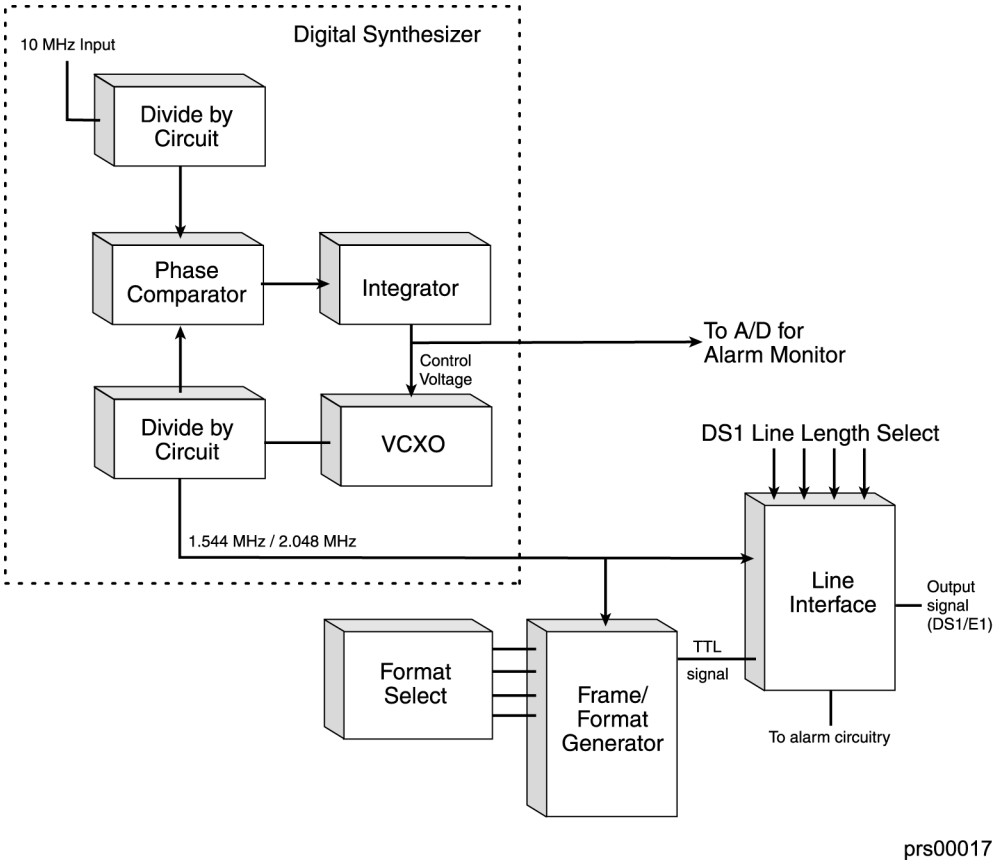


Figure 3-3 Block Diagram of Telecom Synthesizer

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.

IN THIS CHAPTER:

Chapter 4 Service and Maintenance

This chapter describes the service and maintenance activities for the Datum PRS-50.

Note: Datum offers a 24-hour technical support line and a 2-hour response time for each trouble call. For Customer Service, Call: (512) 721-4032 or (866) 638-7962 (866 NET-SYNC) during normal business hours (8 a.m. to 5 p.m. CST), or (512) 721-4000 after hours and on weekends, Fax: (512) 251-9685, or E-mail: austinsupport@datum.com.

4.1 Service

If the CRITICAL ALARM indicator remains lit, indicating a failure of the PRS-50, the instrument may be serviced by replacing the cesium module behind the front cover. To replace the cesium module, refer to Figure 4-1 as necessary:

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**.

Caution: To avoid damage to the unit, be sure to secure cables during removal and replacement.

Warning: To avoid possible injury to the user and/or damage to the unit, take care not to drop the cesium module, which weighs 25 pounds (9.8 kg).

6. Utilizing the handles provided, carefully remove the cesium module from the unit.

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 requires that you enter the new serial number.

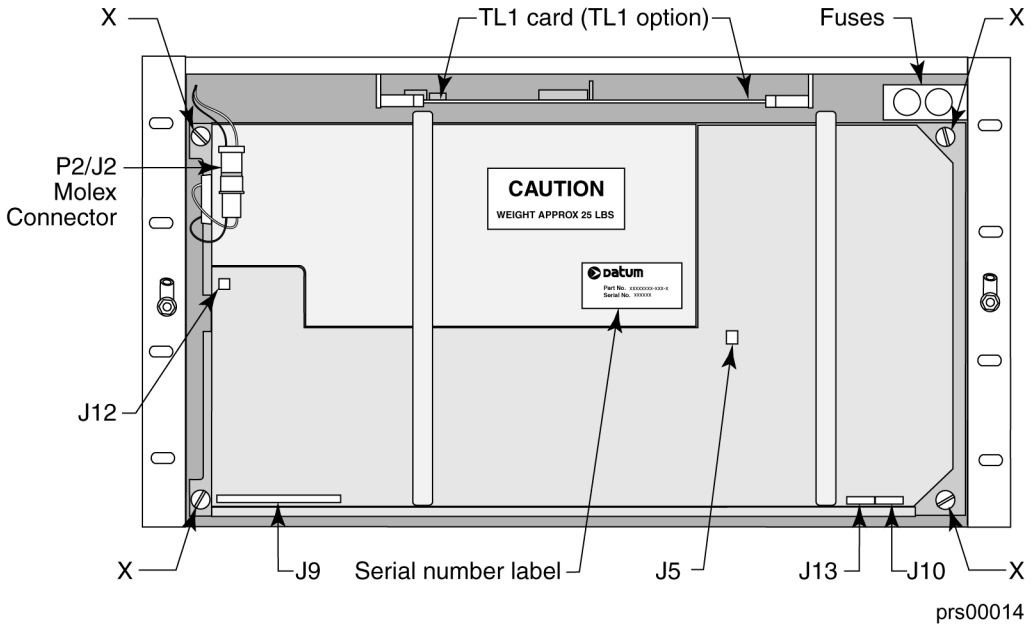


Figure 4-1 Interior View of PRS-50 for Servicing

4.2 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 Datum's Customer Service department at 1-512-721-4000 for assistance.

4.2.1 Preventive Maintenance

The PRS-50 unit requires no preventive maintenance. Care should be taken to ensure that 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: To avoid damage to the PRS-50, water ***should not*** come into contact with the interior of the PRS-50.

Caution: To avoid damage to the unit, never attempt to vacuum the PRS-50. This may cause an electromagnetic discharge.

4.2.2 Re-Ordering Information

Contact your local Datum sales office to re-order any subassembly or accessory or to obtain a current list of available subassemblies, accessories, and item numbers (see Section 4.2.3, Accessories). When you know what items you are ordering, supply the subassembly or accessory name and its item number along with your purchase order number to our sales office.

4.2.3 Accessories

Table 4-1 lists accessories and their respective item numbers.

Table 4-1 Accessories for the PRS-50

Item	Assembly Name	Item Number
Software	Control Monitor PC Application (DOS)	14181214-000-0
	Datum Instrument Monitor (TL1) PC Application (Windows)	14181478-000-0
	SynCraft	14113245-100-0
RS-232 null modem cable	DB9 F/F, Crossover	805RS23-2001
Spare Fuse	3.15 Amp, 250 V, fast-acting, metric	552001-0028
RS-232 pass-through cable	DB25m/D9F, 6 ft.	805S925P6

4.3 Preparing the PRS-50 for Shipping

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 an appropriate hazardous material (HAZMAT) shipping container.

4.3.1 Procedure for Returning Products

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

1. Call Datum's Customer Service at 1-512-721-4000 to obtain a return authorization number (RMA) 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, email address.)

4. Follow the shipping guidelines described in Section 4.3.2, Hazardous Material Shipping Considerations

5. Ship the product to Datum, transportation prepaid and insured, with the Return Material Authorization (RMA) number and serial number clearly marked on the outside of the container to:

   Datum, Inc.
   15811 Vision Drive
   Pflugerville, TX 78660

   Attention: Service Department

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 4.3.2, Hazardous Material Shipping Considerations. 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.

4.3.2 Hazardous Material 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

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. Figure 4-2 illustrates the proper placement of labels. Make sure the address label, proper HAZMAT labels, and packing slip (if necessary) are affixed to the shipping case and are clearly visible.

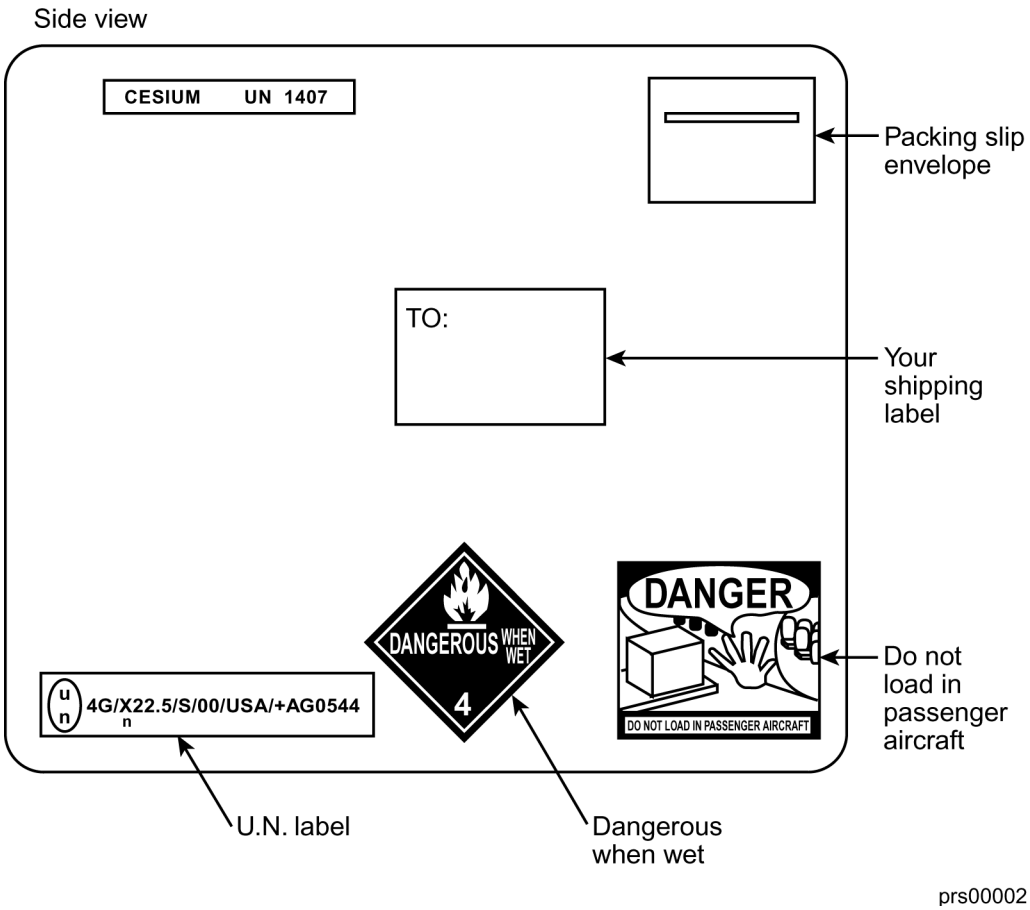


Figure 4-2 Typical Shipping Label Placement

Table 4-2 provides information that is typically requested by the carrier:

Table 4-2 Hazardous Material Shipping Information

Description	Specification
Proper Shipping Name	Caesium (Cesium) Dangerous When Wet
Class Or Division	4.3
UN or ID No.	UN1407
Type Of Packing	Fiberboard Box
Packing Instructions	412

4.3.3 Shipping Carriers

Several United States and international shipping companies, such as Emery and Federal Express, can accommodate properly packaged hazardous materials. Contact one of these shipping companies for assistance. If you need additional help, call Datum Technical Service at 512-721-4000.

IN THIS APPENDIX:

Appendix A TL1 Syntax

This appendix provides information 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. It also includes specific information on the TL1 commands implemented in the PRS-50.

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

This section provides information to familiarize you with the formal TL1 syntax and how it is implemented in the Datum PRS-50. For more information, refer to Telcordia's Technical Reference TR-NWT-000831.

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; if an unused field is the last parameter in the parameter list (for example the General Block or the Payload), it can be omitted. Descriptions of TL1 command structure elements are shown in Table A-1.

Table A-1 Structure of TL1 Input Command Messages

Command	Description
VERB-MODIFIER ==	Command verb with modifier
<TID> == <target identifier>	Optional – up to 32-character name field
<AID> == <access identifier>	“ID” plus the 5-digit unit serial number (the last five digits of the ten-digit serial number tag located inside the cesium module front-panel door) e.g. ID01001; also ID00000
<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 the PRS-50
<PL> == <payload>	Optional – not used by the PRS-50

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 <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 is:

```
M^<CTAG>^COMPLD
```

An example of an optional text block response is:

```
“<blank line>”
“   PRS-50 02-09-09 15:03:48”
“M 1032 COMPLD”
“A ,00,00,00,00,00”
“;”
```

For an unsuccessfully completed input command (command-denied response), the format of the response is:

```
M^<CTAG>^DENY
```

A four-character error code is returned, indicating the cause of the DENY response. An example of a text block response is:

```
"<blank line>"
"   PRS-50 02-09-09 15:03:50"
"M 1032 DENY"
"IICM"
";"
```

The errors codes listed in Table A-2 may be returned by the PRS-50 in a DENY response.

Table A-2 TL1 Error Codes for Deny Response Messages

Code	Description
IBEX	Extra block in command
IBMS	Missing block in command
ICNV	Command Not Valid
IIAC	Invalid AID code
IICM	Invalid command
IICT	Invalid CTAG
IITA	Invalid Target Identifier
IPEX	Extra parameter
IPMS	Parameter missing
IPNV	Parameter not valid
ISCH	Invalid character, syntax
ISPC	Invalid punctuation, syntax
SDBE	Database error
SDNR	Data not ready
SRAC	Requested access configuration in invalid
SROF	Requested operation failed
SWFA	Working unit failed

A.3 Autonomous Reports

Autonomous reports are generated when the PRS-50 detects an alarm status change. The alarm status is updated whenever the alarm status changes, including whenever the user sets or clears an alarm. The message appears on connector J2 on the front panel and on connector J4 on the rear panel.

The alarm status report has the following format:

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
almcde^atag^REPT^ALM<cr><lf>
<text_block><cr><lf>
;
```

Example:

```
   PRS-50 02-09-09 09:59:09
*C 1166 REPT ALM
"02,03,18,00,00
;
```

The <almcde> reports the level of the alarm: "*C", or "*^"; indicating Critical alarm or Minor Alarm message, respectively. The atag is a six-digit correlation tag that is incremented each time an autonomous message is sent. The <text_block> displays up to five active alarms, as listed in Table A-3. This message is broadcast 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"`).

Table A-3 Alarm Codes and Descriptions

Alarm Number	Description	Condition
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	

Table A-3 Alarm Codes and Descriptions (Continued)

Alarm Number	Description	Condition
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	
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	>10V for more than 45 min. 4 to 6 quiescent, >10V warm-up
20	oscillator oven reentered 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	< 20V or > 30 V (25 V ± 2 V nominal)
24	DPM1, driver performance monitor	timing output faulted
25	DPM2, driver performance monitor	timing output faulted

A.4 TL1 Commands

The PRS-50 command set follows the TL1 syntax, which is described in Section A.1, Input Command Message Structure. The commands available in the PRS-50 are listed in Table A-4, and are described in the following sections.

Note that the dashes “-” and the colons “:” must be included in the command string, and the string is always terminated with a semi-colon “;”.

Table A-4 TL1 Command Set

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>::p;	Enables command echoing on the specified port p={1,2}, 1 = rear port; 2 = front port
SET-ECHO-OFF::<AID>:<CTAG>::p;	Disables command echoing on the specified port p={1,2}, 1 = rear port; 2 = front port
SET-TID::<AID>:<CTAG>::<TID>;	Set unit target identifier to alphanumeric string up to 32 characters, starting with a letter
SET-TIME::<AID>:<CTAG>:: YY,MM,DD,HH,MM,SS;	Set unit time and date (all fields must be entered)
SET-BAUD::<AID>:<CTAG>::n,p;	Set unit baud rate on specified port: n={12,24,48,96,192}, actual rate = n*100; default is 9600 p={1,2}, 1 = rear port; 2 = front port
SET-USER-COMM::<AID>:<CTAG>::n,p;	Set unit comm port parameters: n={0,1}, 0 = None, 8, 1 (default); 1 = Odd, 7, 2 p={1,2}, 1 = rear port; 2 = front port
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

A.5 Set Commands

Each Set command submitted by the user causes the PRS-50 to respond with the Complied message.

Valid <tid> code: the assigned tid (see SET-TID; the default TID is PRS50) or null. If null, the PRS-50 requires the <aid>.

Valid <aid> code:

- Null (no characters). If null, the PRS-50 requires the <tid>
- ID#####, where ##### is the last five digits of the 10-digit serial number
- ID00000

A.5.1 Set Alarm Cutoff

The Set Alarm Cutoff command sets the alarm relays to the non-alarm state.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax	`SET-ALM-CUTOFF:[tid]:[aid]:ctag::;`

Response Format	`<cr><lf><lf>`
	`^^^sid^ocrdat^ocrtim<cr><lf>`
	`M^ctag^COMPLD<cr><lf>`
	`;`

Example Command	`SET-ALM-CUTOFF:PRS-50:ID01533:1::;`

Example Response	`PRS-50 02-09-06 11:26:20`
	`M 1 COMPLD`
	`;`

A.5.2 Set Auxiliary Output

The Set Auxiliary Output command provisions the output frequency of the system's sine wave output. Table A-5 lists the values of the *n* parameter and the resulting output frequency.

Table A-5 Setting the Output Frequency

Value of *n*	Output Frequency (MHz)
2	1
3	5
4	10

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-AUXOUT:[tid]:[aid]:ctag::n;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-AUXOUT:PRS-50:ID05203:13::2;
```

Example Response

```
   PRS-50 02-05-16 13:35:55
M 13 COMPLD
;
```

A.5.3 Set Baud

The Set Baud command provisions the baud rate of the specified serial port. Table A-6 lists the values of the *n* parameter and the resulting baud rate and the *p* parameter and the associated port. If *r* is not specified, then the baud rate is set on the port that the command is sent on.

Table A-6 Setting the Baud Rate

Value of *n*	Baud Rate	Value of *r*	Port
12	1200	1	Rear
24	2400	2	Front
48	4800		
96	9600		
192	19200		

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-BAUD:[tid]:[aid]:ctag::n,p;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-BAUD:PRS-50:ID05203:11::24;
```

Example Response

```
   PRS-50 02-05-16 15:02:19
M 11 COMPLD
;
```

A.5.4 Set Clear Alarms

The Set Clear Alarm command clears all alarms from the alarm list and returns the alarm relays to the non-alarm state (see Section A.5.1, Set Alarm Cutoff). If alarms are active when the Set Clear Alarms command is sent, the PRS-50 responds with an Alarm Clear event.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-CLRALM:[tid]:[aid]:ctag::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-CLRALM:PRS-50:ID05203:1::;
```

Example Response

```
   PRS-50 02-05-16 13:46:16
M 1 COMPLD
;

   PRS-50 02-05-16 13:46:16
A 1194 REPT ALM
"00,00,00,00,00"
;
```

A.5.5 Set Clear Event Log

The Set Clear Event Log command clears the event history buffer in the PRS-50.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax	`SET-CLR-EVENTLOG:[tid]:[aid]:ctag::;`

Response Format	`<cr><lf><lf>`
	`^^^sid^ocrdat^ocrtim<cr><lf>`
	`M^ctag^COMPLD<cr><lf>`
	`;`

Example Command	`SET-CLR-EVENTLOG:PRS-50:ID05203:14::;`

Example Response	`PRS-50 02-05-16 14:36:46`
	`M 14 COMPLD`
	`;`

A.5.6 Set Echo On

The Set Echo On enables the serial port to echo characters back to the serial port as the character is received. There are two TL1 serial ports that can be provisioned. Table A-7 lists the valid values of the *p* parameter and the associated port.

Table A-7 Selecting the Port to Provision

Value of *p*	Port
1	Rear
2	Front

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-ECHO-ON:[tid]:[aid]:ctag::p;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-ECHO-ON:PRS-50:ID05203:15::1;
```

Example Response

```
   PRS-50 02-05-16 14:45:49
M 15 COMPLD
;
```

A.5.7 Set Echo Off

The Set Echo Of disables the serial port from echoing characters back to the serial port as the character is received. There are two TL1 serial ports that can be provisioned. Table A-7 lists the valid values of the *p* parameter and the associated port.

Table A-8 Selecting the Port to Provision

Value of *p*	Port
1	Rear
2	Front

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-ECHO-OFF:[tid]:[aid]:ctag::p;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-ECHO-OFF:PRS-50:ID05203:15::2;
```

Example Response

```
   PRS-50 02-05-16 14:51:32
M 15 COMPLD
;
```

A.5.8 Set Target Identifier

The Set Target Identifier command assigns a target identifier (<tid>) to the PRS-50.The <tid> is required to access the system if the <aid> is not specified. Valid <tid> names consist of up to 32 alphanumeric characters, starting with a letter.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax	`SET-TID:[tid]:[aid]:ctag::TID;`

Response Format	`<cr><lf><lf>`
	`^^^sid^ocrdat^ocrtim<cr><lf>`
	`M^ctag^COMPLD<cr><lf>`
	`;`

Example Command	`SET-TID:PRS-50:ID05203:15::DATUM;`

Example Response	`DATUM 02-05-16 16:21:05`
	`M 15 COMPLD`
	`;`

A.5.9 Set Time

The Set Time command assigns a new date and time to the PRS-50.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax	`SET-TIME:[tid]:[aid]:ctag::YY,MM,DD,HH,MM,SS;`

Response Format	`<cr><lf><lf>`
	`^^^sid^ocrdat^ocrtim<cr><lf>`
	`M^ctag^COMPLD<cr><lf>`
	`;`

Example Command	`SET-TIME:PRS-50:ID05203:623::02,09,11,09,45,00;`

Example Response	`PRS-50 02-09-11 09:45:00`
	`M 623 COMPLD`
	`;`

A.5.10 Set User Communication

The Set User Communication command provisions the parameters of the specified serial port. The parameters are word length, (8 or 7 bits), Parity (None or Odd), and stop bits (1 or 2). Table A-9 lists the valid values of the *n* and *p* parameters and associated port parameters and port. If *p* is not specified, then the parameters are set on the port that the command is sent on.

Table A-9 Selecting the Port Parameters

Value of *n*	Port Parameters	Value of *p*	Port
0	8-None-1	1	Rear
1	7-Odd-2	2	Front

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
SET-USER-COMM:[tid]:[aid]:ctag::n,p;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
;
```

Example Command

```
SET-USER-COMM:PRS-50:ID05203:15::0;
```

Example Response

```
   PRS-50 02-05-16 08:11:14
M 15 COMPLD
;
```

A.6 Retrieve Commands

Each Retrieve command submitted by the user causes the PRS-50 to respond with the Complied message and a response message that contains the requested data.

Valid <tid> code: the assigned tid (see SET-TID; the default TID is PRS50) or null. If null, the PRS-50 requires the <aid>.

Valid <aid> code:

- Null (no characters). If null, the PRS-50 requires the <tid>
- ID#####, where ##### is the last five digits of the 10-digit serial number
- ID00000

A.6.1 Retrieve Alarms

The Retrieve Alarms command reports up to five active alarms in the PRS-50. The text_block contains the highest-severity alarm level of all alarms in the list, and contains the most recent alarms.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2)..

Command Syntax

```
RTRV-ALMS:[tid]:[aid]:ctag:::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
^^^text_block<cr><lf>
```

Example Command

```
RTRV-ALMS:PRS-50:ID01533:1:::;
```

Example Response

```
   PRS-50 02-02-25 03:01:36
M 1 COMPLD"
"A ,00,00,00,00,00"
```

or

```
   PRS-50 02-05-15 09:57:25
M 1 COMPLD"
"*C,03,18,00,00,00"
;
```

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 the alarm state code represent the faults raised in the PRS-50 and are listed in Table A-3.

A.6.2 Retrieve Constants

The Retrieve Constants command reports a list of thirteen factory settings that are stored in the PRS-50 at the factory. The contents of the *text_block* contain the constants listed in Table A-10 in a comma-separated format.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
RTRV-CONS:[tid]:[aid]:ctag::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
^^^text_block<cr><lf>
```

Example Command

```
RTRV-CONS:PRS-50:ID01533:1::;
```

Example Response

```
   PRS-50 02-05-15 13:17:40
M 1 COMPLD
   "11.1,0.86,256,+00,+00,+00,+00,+0000,+0006,05.0,UK,
 08-28-98,370 1.8"
;
```

Table A-10 PRS-50 Constants

No.	Name	Description	Example
1	Mass spec voltage	Nominal level, stored at the factory	14.0
2	Ionizer voltage	Nominal level, stored at the 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, stored at the factory	+00
5	f compensation	At +15°C, stored at the factory	+00
6	f compensation	At +45°C, stored at the factory	+00
7	f compensation	At +75°C, stored at the factory	+00
8	12.6 MHz level	Nominal level, stored at the factory	+0345
9	Zeeman offset	Asymmetry compensation, stored at the factory	-0045

Table A-10 PRS-50 Constants (Continued)

No.	Name	Description	Example
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	08/28/98
13	Module ROM version	Ver 1.0	1.0

A.6.3 Retrieve Events

The Retrieve Events command reports the last 20 events stored in the PRS-50. The exact number of events depends on the amount of free memory in the PRS-50. Each event contains the event date and time, the alarm code number, and the alarm state (SET or CLR).

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
RTRV-EVENTLOG:[tid]:[aid]:ctag::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
^^^"ocrdat^ocrtim^almcode^almstate<cr><lf>
ocrdat^ocrtim^almcode^almstate<cr><lf>
...
ocrdat^ocrtim^almcode^almstate"<cr><lf>
```

Example Command

```
RTRV-EVENTLOG:PRS-50:ID5203:1234::;
```

Example Response

```
   PRS-50 02-05-15 19:06:19
1234 COMPLD
   "96-01-01 00:00:00 30 Set
02-05-10 14:02:28 30 Clr
02-05-10 14:02:57 27 Set
02-05-10 14:02:58 26 Clr
02-05-10 14:03:20 27 Clr
02-05-10 14:11:23 27 Set
02-05-10 14:11:45 26 Clr
02-05-13 15:17:01 27 Set
02-05-13 15:17:46 27 Clr
02-05-14 13:54:20 27 Set
02-05-14 13:54:43 27 Clr
02-05-14 18:41:16 26 Set
02-05-14 18:41:38 26 Clr
02-05-14 18:42:44 26 Set
02-05-15 11:53:33 26 Clr
02-05-15 12:49:59 26 Set
02-05-15 12:51:05 26 Clr
"
;

   PRS-50 02-05-15 19:06:19
M 1234 COMPLD
```

A.6.4 Retrieve Firmware Version

The Retrieve Firmware Version command reports the revision level of the TL1 card firmware. It does not report the revision level of the cesium physics package.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
RTRV-FWVER:[tid]:[aid]:ctag::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
^^^"Firmware Version #.#<cr><lf>
Dwg. #11371 Rev #"<cr><lf>
```

Example Command

```
RTRV-FWVER:PRS-50:ID5203:1::;
```

Example Response

```
   PRS-50 02-09-10 19:00:19
M 1 COMPLD
   "Firmware Version 1.7
Dwg. #11371 Rev D"
```

A.6.5 Retrieve Header

The Retrieve Header command reports the message header information which contains the source identifier, the system date, and the system time.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax	`RTRV-HDR:[tid]:[aid]:ctag::;`

Response Format	`<cr><lf><lf>`
	`^^^sid^ocrdat^ocrtim<cr><lf>`
	`M^ctag^COMPLD<cr><lf>`

Example Command	`RTRV-HDR:PRS-50:ID5203:13::;`
Example Response	`PRS-50 02-09-10 19:00:19` `M 13 COMPLD`

A.6.6 Retrieve Variables

The Retrieve Variables command reports a list of 36 operating parameters, described in Table A-11.

If the PRS-50 successfully receives the command, it returns the COMPLD message. If the PRS-50 does not successfully receive the command, it returns the DENY message with the appropriate TL1 error code (see Table A-2).

Command Syntax

```
RTRV-VARS:[tid]:[aid]:ctag::;
```

Response Format

```
<cr><lf><lf>
^^^sid^ocrdat^ocrtim<cr><lf>
M^ctag^COMPLD<cr><lf>
^^^"text_block"<cr><lf>
```

Example Command

```
RTRV-VARS:PRS-50:ID5203:1::;
```

Example Response

```
   PRS-50 02-09-10 19:00:19
M 1 COMPLD
   "2,R+Z,00,00,00,00,00,00,000,000000,+22.72,01.0,-017,
-00030-12,+0005,-0015,2500,+0003,2207,+0224,1.63,+0002,-
2054,+5.12,+42.8,+15.7,-15.9,c,04.7,14.0,0.73,18.7,08.4,
000,+096"
```

Table A-11 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

Table A-11 PRS-50 Operating Parameters (Continued)

No.	Name	Description	Example
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
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

Table A-11 PRS-50 Operating Parameters (Continued)

No.	Name	Description	Example
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 a 12-year tube	+107

Evaluation

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
	Understandable → ← Applicable
3. Is the manual's content *understandable* and *applicable* to the product's operation? Please explain.	☐ ☐ 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
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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