DL™

User Manual

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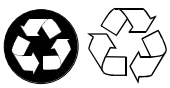
Proprietary Notice



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WARRANTY POLICY

NovAtel Inc. warrants that its Global Positioning System (GPS) products are free from defects in materials and workmanship, subject to the conditions set forth below, for the following periods of time:

DL Series	One (1) Year
GPSAntenna Series	One (1) Year
Cables and Accessories	Ninety (90) Days
Software Support	One (1) Year

Date of sale shall mean the date of the invoice to the original customer for the product. NovAtel's responsibility respecting this warranty is limited solely to product repair at an authorized NovAtel location only. Determination of repair will be made by NovAtel personnel or by technical personnel expressly authorized by NovAtel for this purpose.

THE FOREGOING WARRANTIES DO NOT EXTEND TO (I) NONCONFORMITIES, DEFECTS OR ERRORS IN THE PRODUCTS DUE TO ACCIDENT, ABUSE, MISUSE OR NEGLIGENT USE OF THE PRODUCTS OR USE IN OTHER THAN A NORMAL AND CUSTOMARY MANNER, ENVIRONMENTAL CONDITIONS NOT CONFORMING TO NOVATEL'S SPECIFICATIONS, OR FAILURE TO FOLLOW PRESCRIBED INSTALLATION, OPERATING AND MAINTENANCE PROCEDURES, (II) DEFECTS, ERRORS OR NONCONFORMITIES IN THE PRODUCTS DUE TO MODIFICATIONS, ALTERATIONS, ADDITIONS OR CHANGES NOT MADE IN ACCORDANCE WITH NOVATEL'S SPECIFICATIONS OR AUTHORIZED BY NOVATEL, (III) NORMAL WEAR AND TEAR, (IV) DAMAGE CAUSED BY FORCE OF NATURE OR ACT OF ANY THIRD PERSON, (V) SHIPPING DAMAGE; OR (VI) SERVICE OR REPAIR OF PRODUCT BY THE DEALER WITHOUT PRIOR WRITTEN CONSENT FROM NOVATEL.

IN ADDITION, THE FOREGOING WARRANTIES SHALL NOT APPLY TO PRODUCTS DESIGNATED BY NOVATEL AS BETA SITE TEST SAMPLES, EXPERIMENTAL, DEVELOPMENTAL, PREPRODUCTION, SAMPLE, INCOMPLETE OR OUT OF SPECIFICATION PRODUCTS OR TO RETURNED PRODUCTS IF THE ORIGINAL IDENTIFICATION MARKS HAVE BEEN REMOVED OR ALTERED.

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NOVATEL SHALL NOT BE LIABLE FOR ANY LOSS, DAMAGE OR EXPENSE ARISING DIRECTLY OR INDIRECTLY OUT OF THE PURCHASE, INSTALLATION, OPERATION, USE OR LICENSING OR PRODUCTS OR SERVICES. IN NO EVENT SHALL NOVATEL BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR NATURE DUE TO ANY CAUSE.

There are no user-serviceable parts in this device, and no maintenance is required. When the status code indicates that a unit is faulty, replace with another unit and return the faulty unit to NovAtel Inc.

You must obtain a **RETURN MATERIAL AUTHORIZATION** (**RMA**) number by contacting Customer Service in any of the ways described on the next page. This number is needed *before* shipping any product to NovAtel or your Dealer.

Once you have obtained an RMA number, you will be advised of proper shipping procedures to return any defective product. When returning any product to NovAtel, please return all original diskettes along with the defective product in the original packaging to avoid electrostatic and/or shipping damage.

ANY ATTEMPT TO OPEN THE CASE WILL IMPAIR THE WATER-RESISTANT QUALITIES OF THE ENCLOSURE, AND VOID THE WARRANTY.

CUSTOMER SERVICE

For customer support contact your local NovAtel dealer first. If the problem remains unresolved, contact NovAtel directly by any of the following ways:

- toll-free hotline: 1 800 NOVATEL (8:00 AM - 4:30 PM MST, Canada and U.S.A. only)
- telephone: 1 403 295 4900 (8:00 AM - 4:30 PM MST)
- fax: 1 403 295 4901

- e-mail: support@novatel.ca
- web site: http://www.novatel.ca

- regular mail: NovAtel Inc.
  Customer Service Dept.
  1120 - 68 Avenue NE
  Calgary, Alberta
  Canada
  T2E 8S5

If you require customer service, please provide the following information along with a detailed description of the problem when you call or write:

Serial No._____ Model No. _____

Software Release No. _____

Date Purchased:_____

Purchased from: _____

User name: _____ Title:_____

Company: _____

Address:_____

City:_____ Prov/State: _____

Zip/Postal Code: _____ Country: _____

Phone #:_____ Fax #: _____

E-mail:_____

Interface: Computer type: _____ Operating Shell: _____

Other interface used:_____

Please provide a complete description of any problems you may be experiencing, or the nature of your inquiry (attach additional sheets if needed):

_____

_____

_____

_____

_____

NOTICE

FCC NOTICE

The United States Federal Communications Commission (in 47 CFR 15) has specified that the following notices be brought to the attention of users of this product.

"This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own risk."

"Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."

IMPORTANT: In order to maintain compliance with the limits of a Class A digital device, it is required to use properly shielded interface cables (such as Belden #9539 or equivalent) when using the serial data ports, and double-shielded cables (such as Belden #9945 or equivalent) when using the I/O strobe port.

CE NOTICE

WARNING: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

CAUTION!

1. This device incorporates circuitry to absorb most static discharges. However, severe static shock may cause inaccurate operation of the unit. Use anti-static precautions where possible.
2. This device is a precision instrument. Although it is designed for rugged operating conditions, it performs best when handled with care.
3. When the cover for the PC Card ATA mass storage card (PC Card) is closed and latched, the enclosure is sealed to provide protection against adverse environmental conditions. To minimize the possibility of damage, always keep this cover closed and latched except when exchanging PC Cards. **Any attempt to remove this cover or the end-caps impairs the water-resistant qualities of the enclosure, and void the warranty.**
4. Do not eject the PC Card while the DL is logging data, as you may lose part of or your entire data file.
5. The DL can accept an input supply voltage in the range +10.7 to +18 V DC. This may not be the same range as other NovAtel products with which you are familiar. Operating the DL below 10.7 V DC causes the unit to suspend operation. An input voltage above +18 V DC may physically damage the unit.
6. The DL is not compatible with the ProPak series of power supplies and power cables.
7. Drawing more than the specified maximum current (2 amps) from COM2 will cause an internal fuse to interrupt the current. Restoring normal operation will require returning the unit to NovAtel.

FOREWORD

Congratulations on your purchase of the DL, a GPS receiver with exceptional flexibility.

NovAtel is an industry leader in state-of-the-art GPS receiver design. We believe that our DL will meet your high expectations, and are working hard to ensure that future products and enhancements will maintain that level of satisfaction.

Scope

This manual provides sufficient information to allow you to set up and effectively use the DL. For any customer-service problems or inquiries, please contact your dealer. If additional help is needed, contact Customer Service by any of the means outlined on *Page 8*.

The following may provide you with additional valuable reference information:

- *SoftSurv User Manual* - a description of the SoftSurv suite of GPS surveying programs and utilities. SoftSurv and DL are complementary products designed to work together. SoftSurv software provides a user-friendly graphical interface to the DL, allowing you to focus on your work without needing to learn about the MiLLennium's commands and logs. SoftSurv contains all that you would typically need to interact with and configure the DL.
- *MiLLennium GPSCard Command Descriptions Manual* - a comprehensive description of every GPSCard command and log available to you. You would only need to become familiar with this manual if you wished to interact with the DL from the command-prompt interface, or in any other way chose not to use SoftSurv.

Throughout this document, metric SI (Système Internationale) units are used. *Appendix G* is included to assist you with conversions to imperial units.

Wherever software commands are listed or described, certain conventions are followed. These are explained in the section titled *Syntax Conventions, Page 47*.

WHAT'S NEW IN THIS EDITION

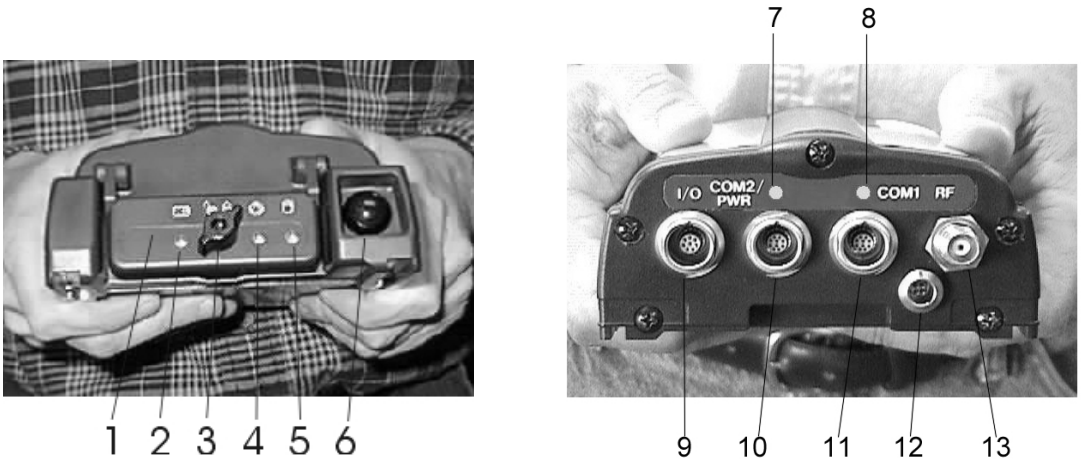
1. Peripheral equipment power can now be provided through the receiver's COM2 port. The output voltage is the same as the connected active battery, with up to 2A of current available. This new definition of COM2 is fully compatible with COM1, NovAtel cabling and other NovAtel ProPak receivers. Refer to the new VOUT command, *Page 63* and pinout description, *Page 42*.
2. GPS receiver firmware has been enhanced to provide superior stand-alone base station operation.
3. The DIR command, *Page 49*, has been modified to display previously supplied additional group information.
4. There is a new WRITE command, *Page 63*, that allows data to be written to a specified data file on the PC Card.
5. There is a new description of the PDC LOG command, *Page 55*, as well as a new PDC log, STATUSA/B, *Page 83*.
6. A PROJECT command, *Page 56*, and a PROJECTA/B log, *Page 78*, has been added for project-related parameters.
7. The GROUP command, *Page 50*, has been modified and a GROUPA/B log, *Page 66*, has been added to provide support for additional group data.

1 - OVERVIEW

The NovAtel DL is a high-performance GPS receiver. In applications when continuous user interaction is required, such as in GIS surveying, a simple handheld controller, that does not require its own data logging memory, can be used with DL. The reduced handheld data logger or controller requirements simplify your system and reduce its total cost and power consumption. Depending on which model you purchase, it is capable of receiving and tracking the L1 C/A-code, L1 and L2 carrier phase, and L2 P-code (or encrypted Y-code) of up to 12 GPS satellites. The DL can be used for either single-point or differential applications. Patented Narrow Correlator tracking technology circuits combined with a powerful 32-bit microprocessor make possible multipath-resistant processing at high data update rates. Excellent acquisition and re-acquisition times allow this receiver to operate in environments where very high dynamics and frequent interruption of signals can be expected. It features a rugged, reliable design for use in adverse environments. The DL is engineered to provide years of reliable operation.

Figure 1 shows front (left photo) and rear (right photo) views of the DL.

Figure 1: NovAtel DL – Front & Rear



#	Description	#	Description
1	PC Card access door	8	COM1 port indicator
2	Power status indicator	9	I/O port
3	Door latch	10	COM2/PWR serial/power port
4	Position status indicator	11	COM1 serial port
5	Logging status indicator	12	Power port
6	Power switch	13	Antenna connector
7	COM2 port indicator		

Once you connect the DL to an antenna and power supply, it begins operating as a fully functional GPS receiver (see *Chapter 2, Set Up*, for more information on this topic). The DL is then ready for the most demanding applications – such as survey, flight inspection, hydrographic survey and dredging, photogrammetry, agricultural applications, GIS and differential reference station applications.

⚠ See *CAUTION!*, *Page 9*, for a list of items of which you should be aware as you set up and use the DL.

MODELS & FEATURES

Table 1 lists the four available DL models available, each capable of multiple positioning modes of operation:

Table 1: Positioning Modes of Operation

Positioning Modes of Operation	DL Model			
	DL-L1	DL-RT20S	DL-L2	DL-RT2
Single point	√	√	√	√
Waypoint navigation	√	√	√	√
Pseudorange differential corrections (TX & RX)	√	√	√	√
Trimble CMR differential corrections (TX versions ≤ 3 & RX version 3)	√	√	√	√
RTK pseudorange & carrier-phase double differencing: < 20 cm RMS accuracies (floating)	×	√	×	√
RTK pseudorange & carrier-phase double differencing: < 2 cm RMS accuracies (fixed)	×	×	×	√
Reverse-RTK	×	√	×	√

Each model has the following standard features:

- rugged shock, water, and dust-resistant enclosure
- NovAtel's advanced MiLLennium L1/L2 GPS technology
- capability to log data to a removable Type II or Type III PC Card ATA mass storage card (PC Card) – eliminates the need to purchase additional data logger peripheral equipment when continuous user interaction is not required
- capability to perform autonomous scheduled data collection, with the ability to go into low-power "sleep" mode between scheduled data-collection sessions
- smart power sensing from two independent batteries, which permits automatic switchover
- two bi-directional serial ports, one of which has power, which support data transfer rates of up to 115,200 bit/second
- obsolescence prevention due to field-upgradeable firmware (program software). What makes one DL model different from another is software, not hardware. This unique feature means that the firmware can be updated anytime, anywhere, without any mechanical procedures whatsoever. For example, a DL model with L1-only capabilities can be upgraded to a model with L1/L2 RT-2 in only a few minutes in your office; instead of in the days or weeks that would be required if the receiver had to be sent to a service depot. All that is required to unlock the additional features is a special authorization code. See *Chapter 4* for further detail on this topic.

The DL features integrated memory (PC Card) for data logging, eliminating your need to purchase additional expensive peripheral equipment

In addition, each model has unique features. These are summarized in *Table* 2 on the following page:

Table 2: Feature Summary - DL Models

General	**DL-L1**	**DL-RT20S**	**DL-L2**	**DL-RT2**
L1 Channels (C/A code) & L2 Channels (P code)	12 & 0	12 & 0	12 & 12	12 & 12
Pseudorange measurements	√	√	√	√
Full-wavelength L2 carrier measurements	×	×	√	√
Ionospheric corrections in position calculations	√	√	√	√
2.5-bit sampling	√	√	√	√
Patented Narrow Correlator tracking technology	√	√	√	√
5 Input / Output strobe signals: mark input (position & time), 1PPS timing output, measure output, programmable variable-frequency output, solution status output	√	√	√	√
Fast re-acquisition	√	√	√	√
Peripheral power supply output COM2	√	√	√	√
Output Data Log Formats	**DL-L1**	**DL-RT20S**	**DL-L2**	**DL-RT2**
NovAtel-proprietary ASCII and binary	√	√	√	√
NMEA Standard	√	√	√	√
RINEX Standard	√	√	√	√
RTCM Standard: Types 1,2,3,9,16,59N	√	√	√	√
RTCA Standard: Types 1,7	√	√	√	√
Data Logging Rates (per second)	**DL-L1**	**DL-RT20S**	**DL-L2**	**DL-RT2**
Computed Data: Position, speed, direction, & clock offset	10	10 / 5	5	5
Measured Data (Observations): Pseudorange & carrier phase	20	20	10	10
Receiver Control	**DL-L1**	**DL-RT20S**	**DL-L2**	**DL-RT2**
Clock drift correction	√	√	√	√
Ability to save receiver configuration settings, & almanac	√	√	√	√
Reset (hardware or software activated)	√	√	√	√
Serial port control	√	√	√	√
Datum (table or user-definable)	√	√	√	√
Magnetic variation correction	√	√	√	√
Undulation (table or user-definable)	√	√	√	√
Position, height & velocity constraints	√	√	√	√
Satellite lockout, elevation cut-off and health control	√	√	√	√

OPERATING MODES

Whenever the DL is connected to a power source (regardless of whether the DL is turned "on" or "off"), it detects whether there is a host computer connected to one of its serial ports. For example, this host computer could be a PC running NovAtel SoftSurv Utilities software, or a data logger running suitable software. If a host computer is found, the DL enters Manual mode and waits for a command; otherwise, the DL enters Automatic mode and operates according to stored commands.

- *Manual Operation:* Among other things, a host computer can transmit scheduling and logging parameters, receive collected data, and turn the DL on or off. In this mode, the DL does not need to be tracking satellites, or even have an antenna connected to it.
- *Automatic Operation:* Once the DL receives configuration commands from a host computer, it operates according to these parameters. Up to a week's worth of data collection can be configured in advance.

ACCESSORIES AND OPTIONS

The NovAtel DL can be used with the following accessories:

- SoftSurv software – a suite of programs that allows you to plan your data collection trip, configure your DL or handheld data logger, post-process your collected data, and archive your information sets
- PC Card for data storage
- NovAtel GPSAntenna Model 501, 511, 521, or 531 – single frequency, active antennas designed for high-accuracy applications
- A choke ring is available for the 501 antenna (model A031) and the 531 antenna (model A032)
- NovAtel GPSAntenna Model 502, 503, or 512 - dual frequency, active antennas designed for high-accuracy applications
- A choke ring is available for the 502 antenna (model A032) while the 503 antenna includes one
- NovAtel Model C005, C015, or C030 (5, 15 or 30 m length) coaxial antenna cable
- power cable to connect the DL to an automotive cigarette-lighter adapter
- battery
- bracket to allow the DL to be mounted to a surface or tripod
- 25-pin straight serial cable for compatibility with certain data communications devices
- power cable to connect the DL to one battery (33.5 cm or 75 cm lengths)
- power cable to connect the DL to two batteries (Y-cable)

Should you need to order an accessory or a replacement part, NovAtel part numbers are shown in *Appendix H*.

2 - SET UP

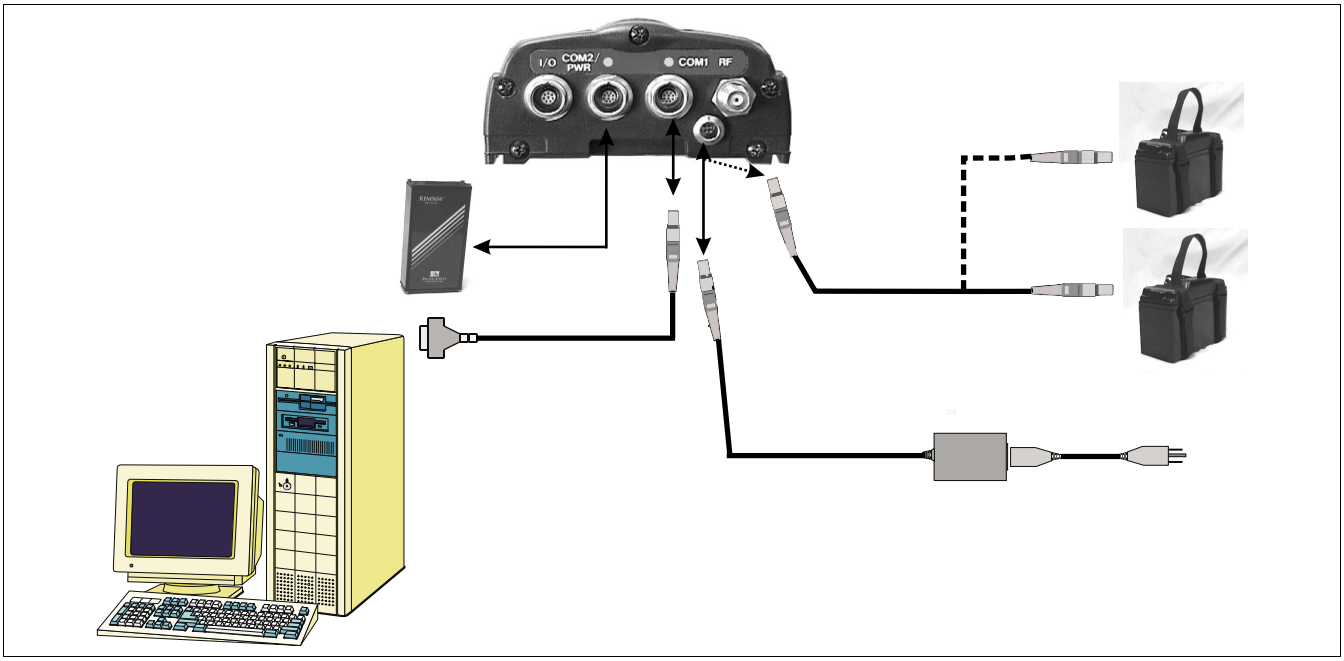
Setting up the DL is a straightforward process, whether you are in the field (collecting data) or back at the office (configuring the DL, or transferring collected data to your PC for post-processing).

⚠ See *CAUTION!*, *Page 9*, for a list of items you should be aware of as you set up and use the DL.

SETTING UP AT THE OFFICE

Figure 2 displays how you might typically set up the DL at the office – for example, to load a schedule, or to transfer collected data to a PC. In this situation, the PC is connected to the COM1 port, and energy is supplied by means of an AC/DC converter that is connected to the Power port.

Figure 2: Typical DL Configuration – Office



For office work, a typical configuration would result from the following steps:

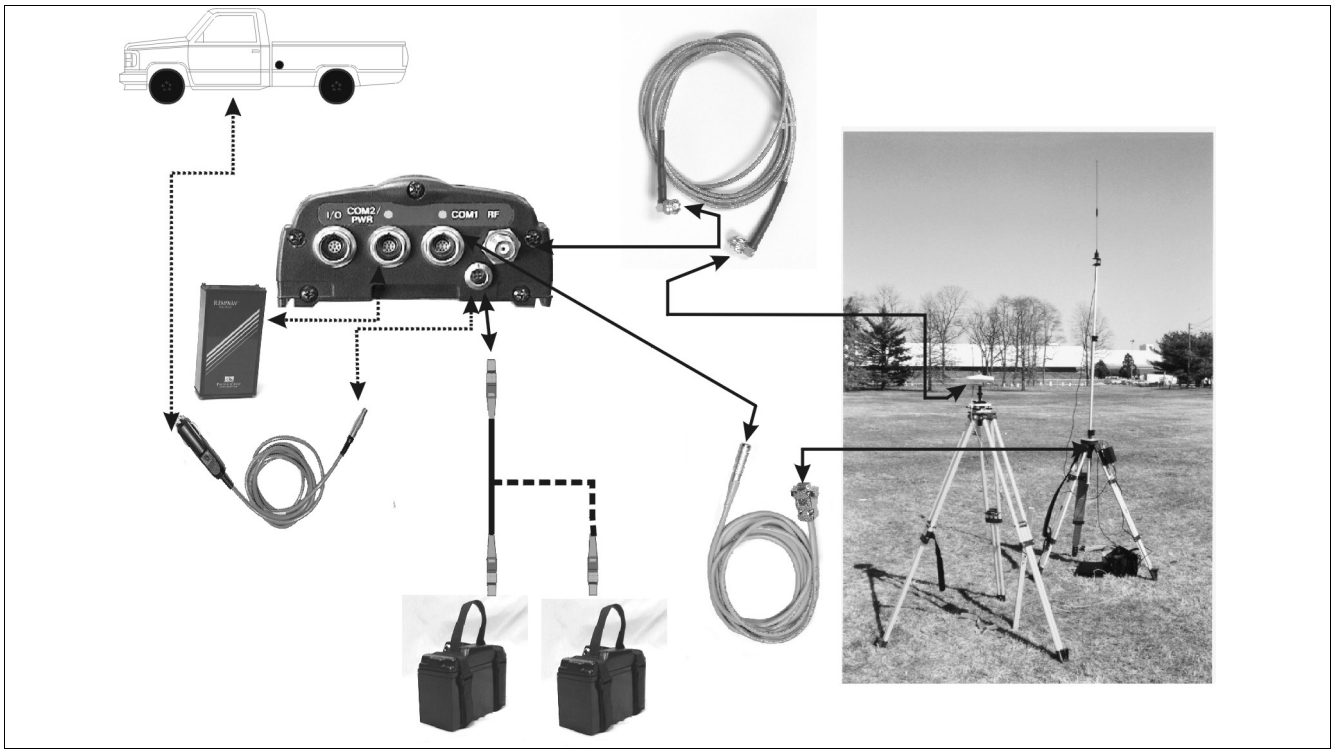
1. Place the DL on a desk or other suitable work surface.
2. Connect an RS232C communication terminal (e.g. PC, data logger) to one of the serial ports of the DL. The supplied null-modem cables are intended for RS232C communications only. See *Serial Ports & Cables*, *Page 20*.
3. Connect the output of a power source (e.g. AC/DC converter) to the input power port of the DL. Once power is supplied, the DL turns on automatically and begins an initialization sequence. See *Power Port & Cable*, *Page 22*.
4. Press the power button or, if you are connected to the DL via a terminal, hit the <Enter> key and wait for a MSGA log with a BOOTOK message to appear. If you are you are using SoftSurv to communicate with the DL, this initial communication is handled by the software.
5. Communicate with the DL, transfer data to the PC (if you have inserted a PC Card containing previously recorded data), or set up a data-collection schedule.

The sections of this chapter give further details on Steps #2 & #3, while *Chapter 3* is devoted to Step #4.

SETTING UP IN THE FIELD

Figure 3 displays how you might typically use the DL in the field – for example, collecting data while receiving differential information over a radio modem from a base station. In this situation, the GPS antenna is connected to the RF port, the radio modem is connected to the COM1 port, and power is supplied by means of two batteries that are connected to the Power port.

Figure 3: Typical DL Configuration – Field



For differential data collection in the field, a typical configuration is described below. This assumes that schedule and logging parameters have already been loaded to the DL (see *Chapter 3*), and that a portable terminal is not being used. If a portable terminal was being used, then at Step #7, when power was supplied, the DL would accept configuration commands from the terminal.

1. Mount or place the DL on a secure, stable structure that will not sway or topple. For example, attach the DL to a tripod leg using the optional mounting bracket (see *Figure 14: Mounting Bracket* and *Figure 15, Appendix I*). Although the unit has a moisture and dust-resistant enclosure, shelter it from adverse environmental conditions when possible.
2. Position the antenna at the desired location – e.g. on a tripod over a survey marker. The recommended antenna depends on which model of the DL you purchased (see *Choose the Right Antenna, Page 17*). For maximum positioning precision and accuracy, as well as to minimize the risk of damage, ensure that the antenna is securely mounted on a stable structure that will not sway or topple. Where possible, select a location with a clear view of the sky to the horizon so that each satellite above the horizon can be tracked without obstruction. The location should also be one that minimizes the effect of multipath interference. For a discussion on multipath, please refer to the appendix on Multipath Elimination Technology in the *MiLLennium GPSCard Command Descriptions Manual*.
3. Route and connect RF coaxial cable between the antenna and DL (see *RF Port & Cables, Page 21*).

4. The receiver provides battery power output (BAT) through COM2. It is possible to turn the supply On or Off using the VOUT command, see *Page 63*. The BAT output is the switched output of the input power supply so that 12V output requires 12V input.
5. RF Port & Cables (*see RF Port &Cable, Page 21*).
6. Connect an RS232C communication device to one of the serial ports of the DL (see *Serial Ports & Cables*, *Page 20*). For example, this might be a radio modem, for receiving differential GPS messages from a base station. The supplied null-modem cables are intended for RS232C communications only.
7. Insert a PC Card into the DL (see *Using the Removable Flash Memory Card*, *Page 23*).
8. Connect the output of a power source (e.g. battery) to the input power port of the DL (see *Power Port & Cable*, *Page 22*). Once power is supplied, the DL turns on automatically, begins an initialization sequence, and then enters low-power mode. See also *System Behavior*, *Page 27*.
9. Exit low power mode by pressing the power button, or if connected via a terminal, by hitting the <Enter> key. If you are going to configure the unit via DL commands, wait for a MSGA log with a BOOTOK message to appear first. Otherwise, the DL will begin logging according to the stored configuration.
10. Monitor the status indicators (see *Status Indicators*, *Page 26*).

The sections of this chapter give further details on these steps.

CHOOSE THE RIGHT ANTENNA

The purpose of an antenna is to convert electromagnetic waves into electrical signals. An active antenna is required. It has a Low Noise Amplifier (LNA) that boosts the strength of received signals to help offset the cable losses. The LNA can be energized directly by the DL, or by another source. NovAtel recommends the use of active antennas only.

The recommended antenna depends on which model of the DL you purchased. *Table 3* lists the allowable antenna types for each of the DL models.

Table 3: Allowable Antenna Types

DL Model	Allowable Antenna
DL-L1	L1-only or L1/L2
DL-RT20S	L1-only or L1/L2
DL-L2	L1/L2
DL-RT2	L1/L2

GPS satellites transmit at two frequencies, 1227.60 MHz (L2) and 1575.42 MHz (L1). NovAtel offers a variety of antenna models for GPS-only operation. All use low-profile microstrip technology and include band-pass filtering and an LNA.

All active GPSAntennas can compensate for up to 13 dB of cable loss. Higher cable loss can be used but you should then expect an increased degradation in signal strength.

The following are L1-only GPSAntennas:

- Model 501 - for use in surveying and other kinematic positioning applications; model A031 choke ring available
- Model 511 - for use in airborne, marine, ground vehicle or backpack applications
- Model 521 - for use in ground vehicle, backpack, or handheld applications
- Model 531 - for use in surveying and other kinematic positioning applications; water proof; model A032 choke ring available

The following are L1/L2 GPSAntennas:

- Model 502 - for use in surveying and other kinematic positioning applications; model A032 choke ring available

- Model 503 - for use with high-performance position-reference stations (features a built-in choke-ring ground plane to minimize the effects of multipath interference)
- Model 512 - for installation on aircraft (features aerodynamic styling)

Each of these models offers exceptional phase-center stability as well as a significant measure of immunity against multipath interference. Each one has an environmentally sealed radome.

A choke ring's unique construction substantially reduces the multipath effect on the GPS signal. The choke ring actually reduces the antenna gain at low elevation, where the multipath is more prone to affect system accuracy. By reducing measurement errors due to multipath, the result is greater accuracy in your positioning calculations.

WARNING: While there may be other antennas on the market that might also serve the purpose, please note that the performance specifications of the DL are guaranteed only when it is used with a NovAtel model 531 (L1) or model 502 (L1/L2) GPSAntenna.

CONNECT CABLES

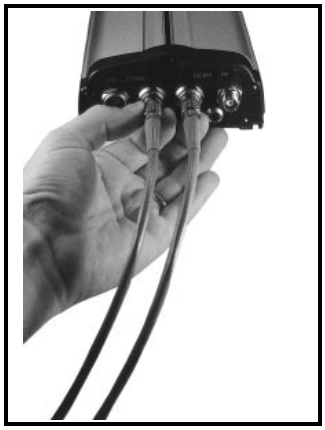
As shown in *Figure 4*, on the rear end-cap there are four labeled ports – I/O, COM2/PWR, COM1, and RF. There is also an unlabelled power input port.

Figure 4: Close-up of Ports on Rear End-cap

Each connector is keyed to ensure that the cable can be inserted in only one way, to prevent damage to both the DL and the cables. Furthermore, the connectors that are used to mate the cables to the DL have a locking mechanism that requires careful insertion and removal. Observe the following when handling the cables.

- To insert a cable, make certain you are using the appropriate cable for the port – the serial cable has a different connector (10 pin) than the I/O cable (8 pin).
- Line up the red dot on the connector shell with the red index mark on the receptacle on the DL.
- Insert the connector until it seats with a click; it is now locked in place.
- To remove a cable, grasp the connector by the knurled ring and pull (see *Figure 5*). DO NOT PULL DIRECTLY ON THE CABLE.

Figure 5: Removing a Connector



I/O PORT & CABLES

DL incorporates an input/output (I/O) port, which allows access to the Mark input, Measure output, VARF output, 1PPS output, and STATUS output signals. These are specialized signals that are used when the DL is part of an interconnected

system composed of devices that need to be synchronized with each other. For example, you could connect the DL to an aerial camera in such a way that the DL recorded its position whenever the shutter button was pressed. This port is not typically used for stand-alone applications. The five signals are described further in *Table 14: I/O Connector Pin Assignment, Page 45*, as well as in the *Input / Output Strobes* section of *Appendix B*.

The I/O strobe lines can be accessed by inserting the 8-pin LEMO connector of the I/O strobe port cable into the I/O port. *Figure 13, Page 45*, and *Table 15: I/O Cable – Pin Assignment, Page 46* contains wiring and pin-out information on this cable. The other end of the cable is provided without a connector so that you can provide an application-specific one; the jacket insulation is cut away slightly from the end but the insulation on each wire is intact.

This port incorporates filters to suppress electromagnetic interference.

See *Appendix H - Replacement Parts* if you need to consult the list of NovAtel and LEMO part numbers.

SERIAL PORTS & CABLES

The two serial ports (COM1 and COM2) are bi-directional. There is a multicolor indicator above each of these serial ports. If it glows *red*, data is being received on that port, while if it glows *green*, data is being transmitted on that port. If it glows *yellow*, data is being received and transmitted simultaneously on that port. The features present for each serial port is listed following:

FEATURES	COM1	COM2
300, 1200, 4800, 9600, 19200, 38400, 57600 and 115,200 BPS data rates	√	√
RS-232C signal levels	√	√
Electromagnetic interference suppression filters	√	√
Hardware and Software flow control operation	√	√
BAT voltage output	×	√

For communication to occur, the DL serial port configuration must match that of the external device's. The DL's default port settings are [RS232C, 9600 BPS, no parity, 8 data bits, 1 stop bit, no handshaking, and echo off]. Changing the default settings can be easily accomplished using SoftSurv *UTILITIES* software module, or by means of the COMn command (which is described in the *MiLLennium GPSCard Command Descriptions Manual).*

On either serial port, only the RX, TX, and GND lines need to be used. Handshaking is not required, although it can optionally be used.

Two serial data cables are supplied to connect the DL to a PC or modem. They are described as follows:

- null-modem cable: 10-pin LEMO plug to 9-pin D-connector (DE9S socket); it is described further in *Figure 12* & *Table , Appendix D, Page 44*. This is used to connect the DL to a serial (RS232C) communication port on a terminal or PC.
- straight cable: 10-pin LEMO plug to 9-pin D-connector (DE9P plug); it is described further in *Figure 11* & *Table , Appendix D, Page 43*. This is used to connect the DL to a modem or radio transmitter to propagate differential corrections.

The 10-pin plug on each cable can be plugged into either the COM1 or COM2 port on the DL.

For further information on the signals or connector pin-outs for the serial ports or cables, please see the *Input / Output Data Interface* section of *Appendix B, Page 37*, and *Table , Page 42*, in *Appendix D*.

See *Appendix H - Replacement Parts, Page 87*, if you need to consult the list of NovAtel and LEMO part numbers.

PERIPHERAL POWER SUPPLY VIA COM2 PORT

The receiver provides battery power output (BAT) through the COM2 port. It is possible to turn the supply On or Off using the VOUT command, see *Page 63*. The BAT output is the switched output of the input power supply so that 12V output requires 12V input.

NOTE: When using peripheral output, it is important to note that the BAT output has a 2-amp fuse. This fuse is non-user replaceable, and if you blow the fuse by trying to draw power greater than 2-amps, you will have to return the receiver to the factory for repair.

Power Control Operation

After initial connection of the power supply to the receiver, the BAT output is turned on.

When the power switch is used to turn the receiver Off, the BAT output is turned on before going to sleep. This ensures that power is available to a potential host system for turning the receiver On again by starting communication with the receiver.

If the power input to the receiver falls below the minimum operating level (both batteries, in the case of a dual battery system), the BAT output is turned Off before the receiver goes to sleep. In this case, both COM activity or the power button will wake the receiver up and BAT remains Off. If the battery input from at least one battery recovers then BAT is turned On again and the unit wakes up as a result of COM activity or by pressing the power button.

RF PORT & CABLES

The radio frequency (RF) port is bi-directional in that it accepts RF signals from the antenna, and it supplies DC power to the low-noise amplifier (LNA) of an active antenna. It has a TNC female connector.

The purpose of an antenna is to convert electromagnetic waves into electrical signals. An active antenna is required. It has a LNA that boosts the strength of received signals to help offset the cable losses. The LNA can be energized directly by the DL, or by another source. NovAtel recommends the use of active antennas only.

For further information on the signals or connector type for the RF port, please see the *RF Input / LNA Power Output* section in *APPENDIX B - DL Specifications, Page 37*.

RF Coaxial Cable

The RF (radio frequency) coaxial cable that you require depends mostly on the distance between the antenna and the DL. Electromagnetic signals are attenuated as they travel along a length of coaxial cable; thus, a long cable introduces more loss in signal strength than a short one of the same type. Good-quality cable introduces lower losses than low-quality cable. If the cable loss becomes too great, excessive signal degradation occurs and the DL may be unable to meet its performance specifications.

An active antenna incorporates a low-noise amplifier (LNA) that boosts the strength of received signals to help offset the cable losses. The LNA can be energized directly by the DL. NovAtel's GPSAntennas can compensate for up to 13 dB of cable loss (see *Choose the Right Antenna*, *Page 17*).

NovAtel offers high-quality coaxial cable in the following lengths: 5 m (Model C005), 15 m (Model C015) and 30 m (Model C030); these come with a TNC male connector at each end. These cables can be used with all GPSAntennas. Should your application require the use of cable longer than 30 m, before you proceed you may wish to contact your dealer or NovAtel Customer Service representative and request *Application Note APN-003, "Extended-Length Antenna Cable Runs"*, or acquire it directly from the Customer Service page of NovAtel's Web site.

NOTE: The coaxial cable should be connected to the antenna and DL *before* power is supplied. If the antenna cable becomes disconnected from the antenna or DL, turn the DL off before reconnecting the cable; this prevents the DL's antenna current-limiting circuit from unnecessarily activating.

Coaxial cables should be handled with care. They should not be routed over surfaces where they could be stepped on, pinched, or cut. A cable that has been stretched, has nicks in its outer jacket, or has crimps resulting from being bent too tightly, generally has higher losses than otherwise.

While there may be other coaxial cables on the market that might also serve the purpose, please note that the performance specifications of the DL are guaranteed only when it is used with NovAtel-supplied RF cables.

POWER PORT & CABLE

The DL requires an input supply voltage that can come from batteries, a wall outlet adapter (AC/DC converter), or an automotive power source. The DL has an internal power module that does the following:

- filters and regulates the supply voltage
- protects against over-voltage, over-current, and high-temperature conditions
- provides automatic reset circuit protection

WARNING: Supplying the DL with an input voltage that is below +10.7 will cause the unit to suspend operation. An input voltage above +18 V DC may physically damage the unit.

The 4-pin power connector allows power to be supplied from two independent sources, although only one is used at a time. If two power sources are available, the DL monitors their supply voltages independently, and on power-up, chooses the one with the higher voltage. If the current power source becomes unusable, the DL then switches to the second one (if available) without any interruption in its logging activities.

Consider the case where the DL is connected to two 12 V DC batteries. As described in *Table 4*, *Page 26*, as the voltage drops on the first battery, the Power indicator color changes from green to amber, then to red. Warning messages are sent on the serial port indicating that battery power is becoming exhausted (see the description of the LPSTATUSA log, *Page 73* and MSGA log, *Page 75* if you require further information). Then, the DL switches to the second battery. Once both batteries are depleted, the DL shuts itself off. To maximize a battery's lifetime, the DL does not use it once it is discharged.

As is also described in *Table 4: Status Indicators - Meaning*, *Page 26*, *w*hen the DL is connected to two batteries, the Power indicator is pulsed (in the appropriate color) to distinguish between battery A and battery B. One long "blink" corresponds to battery A, and two short blinks in rapid succession correspond to battery B. Only the status of the active battery is indicated.

The data logging mechanism is designed to be robust and to endure power interruptions (and similar disruptive events) with minimum loss of data. In these situations, less than 5 minutes of data (prior to the disruptive event) are lost. To the extent possible, error messages attempt to describe the problem. If you require further information on this topic, see the description of MSGA log, *Page 75*.

As shown in *Figure 10: Power Cables*, *Appendix D*, *Page 41* there may be up to four power cables used with the DL. These cables allow you to energize the DL by either an AC source or a DC source:

- 4-pin LEMO plug connector to cigarette-lighter plug, complete with a 3-amp slow-blow fuse
- 4-pin LEMO plug connector to autoranging AC/DC converter/battery charger, and AC power cord
- optional power cable connecting the DL to a battery (33.5 cm or 75 cm lengths)
- optional Y-cable to power the DL from two batteries

For further information on the following topics, see the following sections of this manual:

- For a listing of the required input supply voltages, and the typical power consumption in logging and "sleep" modes, see the *Power Requirements* section of *Appendix B, Page 37*.
- For pin-out information on the 4-pin power connector, see *Table 9: Power Connector Pin Assignment, Page 41*.
- For a listing of the voltage levels at which the Power indicator changes color, or at which the DL switches from one source to another, or at which the DL shuts off, see the *Power Management* section of *Appendix B*. These events are described in *Table 4: Status Indicators - Meaning, Page 26*.
- See *Appendix H - Replacement Parts, Page 87*, if you need to consult the list of NovAtel and LEMO part numbers.

Using a Non-NovAtel Power Cable

If you decide to use a power cable that was not supplied by NovAtel, or make your own, there are a few things that you should keep in mind. There will always be a drop in voltage between the power source and the power port that is due to cable loss. Improper selection of wire gauge can lead to an unacceptable voltage drop at the DL. A paired wire run represents a feed and return line; therefore, a 2-m wire pair represents a total wire path of 4 m. For a DL operating from a 12 V DC battery system, a power cable longer than 2.1 m (7 ft) should not use a wire diameter smaller than that of 24 AWG.

USING THE REMOVABLE FLASH MEMORY CARD

Data can be logged to a PC Card, a flash-memory module which you can access, exchange and replace when needed. The need for a companion handheld data logger is avoided when continuous user interaction is not required, since DL is capable of logging data according to pre-configured parameters without any user intervention. In applications when continuous user interaction is required, such as in GIS surveying, a simple handheld controller can be used with DL, as the controller does not require its own data logging memory. The reduced handheld data logger or controller requirements simplify your system and reduce its total cost and power consumption.

The access door on the DL's front end cap provides a water and dust-resistant seal around the PC Card. The cover latch must be rotated a ¼-turn in order for the cover to seal properly. When the cover is closed and latched, the enclosure is sealed to provide protection against adverse environmental conditions.

WARNING: To minimize the possibility of damage, always keep this cover closed and latched except when exchanging PC Cards.

Collected data can either be transmitted to a host computer over a serial port, or stored on the PC Card. If you choose to log data to the PC Card, each logging session is stored in a single, unique file. These files can then be transferred to a host computer, for data analysis or other types of post-processing, by one of two methods:

- transfer the data by means of serial communications
- physically remove the PC Card from the DL and insert it into the host computer, provided that it is also suitably equipped with a PC Card port

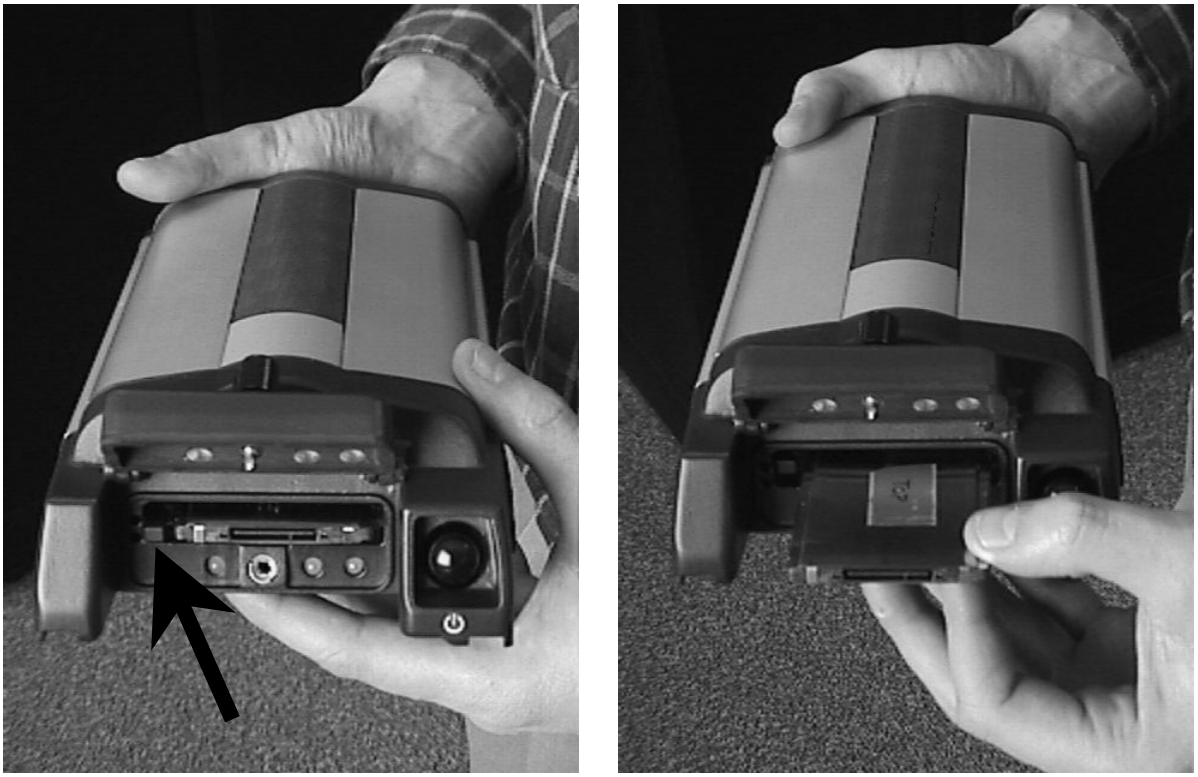
You have the flexibility of choosing the PC Card with the storage capacity that is the most appropriate for your needs, based on the selected logging rate. This is discussed in greater detail in *Data Storage Requirements, Page 30*.

Figure 6 illustrates the procedure to unlock the cover. In the photo on the left, the latch is in the "locked" position. In the photo on the right, the latch is being rotated counter-clockwise into the "unlocked" position. To lock the cover, rotate the latch clockwise. If it resists turning, do not force it; rather, open and close the cover, then try again.

Figure 6: Opening the Cover

Figure 7 illustrates the procedure to remove the PC Card. In the photo on the left, below, the cover has been unlocked and opened, and the PC Card is visible. Note the arrow pointing to the eject button to the left of the card in this view. You must push this button to partially eject the card; then grasp the card as illustrated in the photo on the right, below, and pull it all the way out. To insert the card, ensure that it is correctly aligned before gently sliding it into the slot. When the card slides all the way in and locks in place, the eject button will extend. If you attempt to insert the card incorrectly, it will not go all the way in, and the eject button will not extend. In this case, do not force the card! Remove it, orient it properly, and then insert it. After the card is locked in place, close the cover again.

Figure 7: Handling the PC Card



The data logging mechanism is designed to be robust and to endure power interruptions (and similar disruptive events) with minimum loss of data. In these situations, less than 5 minutes of data (prior to the disruptive event) are lost. When possible, error messages are generated to identify problems as they arise; a description of the MSGA log is contained in *Appendix F, Page 75*.

WARNING: Ejecting the PC Card during a data-recording session will cause data to be lost. When no data is being recorded, however, it is not necessary to turn the DL off before inserting or extracting a PC Card.

SLEEP, POWER DOWN AND THE POWER SWITCH

DL incorporates a power switch on its front end-cap. Pushing this switch sends a signal to the microprocessor to turn on or off the GPS receiver and system peripherals.

The DL has two low-power modes: sleep mode and power-down mode. The modes do not differ in the amount of power consumed, but rather in the way in which the modes are entered into and terminated.

An internal clock, synchronized to GPS time, allows the DL to go into "sleep mode" between scheduled data-collection sessions. This permits the DL to operate reliably while using power sparingly. This is especially important when conducting scheduled data-collection sessions over a period of several days, while using a battery power source. The DL's GPS receiver will "wake" up early enough so that satellite tracking is established prior to the scheduled logging session. Note, however, that exceptional conditions may delay the acquisition of satellites beyond the start of the logging session. For more information on the clock, please see *Real-Time Clock, Appendix B, Page 37*.

Mode	How to achieve mode	Outcome
Sleep	The DL will go into sleep mode by itself between scheduled events, if a command is not received through either serial port for 5 minutes or a SLEEP command is issued, unless a scheduled event is about to take place.	The DL scheduler is still enabled and the DL will wake up from sleep mode prior to a scheduled event.
Power-Down	To enter the low-power mode, press the button until the three status indicators turn red and begin to flash, then release it. This is also the mode entered into after applying the power.	In the power down mode all schedule and logging events are disabled. **Note that while power consumption in power-down mode is minimal the DL is not completely off.** If power conservation is very important, then disconnect the battery from the DL when it is not in use.

In either the sleep mode or power-down mode, pressing the power button momentarily will "wake" up the DL. Also, the DL monitors its serial ports, and becomes fully operational a short while after as serial port activity is detected – for example, if a key is pressed on a handheld data logger that is plugged into one of the DL's serial ports. The time required to wake up is only a few seconds, but it may require an additional few minutes to initialize the GPS receiver and allow it to establish an initial time and position. During the sleeping and wake-up time, the serial ports will not process data. You must wait until receiving the MSGA log with a BOOTOK message (see *Appendix G - Conversions, Page 86*, and *Appendix J - Command Prompt Interface, Page 90*) before typing any commands.

The automatic power-down feature is disabled when logging is in progress. However, if the power switch is pressed while the DL is logging data autonomously, the DL saves any open data files and then goes into power-down mode. For related information see *Autonomous Versus Host Controlled Operation, Page 27*.

An additional function of the power switch is that it resets the DL if it is held depressed for at least 15 seconds. This 'system reset' clears stored logging parameters and reverts to a factory configuration when the power switch is released.

STATUS INDICATORS

As shown in *Figure 8*, the DL's front endcap has three multicolor lights to indicate the status of Power, Position, and Logging, respectively, from left to right. For a labeled view, see also *Figure 1*, *Page 11*.

Figure 8: Status Indicators

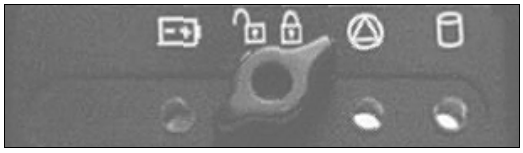


Table 4 shows what the colors of each indicator signify. When the DL is connected to two batteries, the Power indicator is pulsed (in the appropriate color) to distinguish between battery A and battery B. One long "blink" corresponds to battery A, and two short blinks in rapid succession correspond to battery B. Only the status of the active battery is indicated.

Note that during initial power up of the DL or upon wake up from sleep mode, the lights on the DL indicate self-test conditions and therefore the following table does not apply at that time.

Table 4: Status Indicators - Meaning

Indicator	Color	Status Description
Power	Green	Input voltage is good. The light blinks in a single-blink pattern (e.g. ☼ ☼ ☼) if Battery A is good, and in a double-blink pattern (e.g. ☼☼ ☼☼ ☼☼) if Battery B is good.
	Amber blink	The light blinks in a single-blink pattern (e.g. ☼ ☼ ☼) if Battery A is low – battery voltage is less than 10.7 Volts.
	Amber double blink	The light blinks in a double-blink pattern (e.g. ☼☼ ☼☼ ☼☼) if Battery B is low – battery voltage is less than 10.7 Volts.
	Amber	Switching batteries.
	Red	There are no good batteries available. Operation is disabled.
	Amber fast blink	High temperature warning.
	Red fast blink	High temperature shutdown.
	Amber slow blink	High temperature shutdown. Temperature returning to normal (blinks once every five seconds).
	Red slow blink	High temperature shutdown. Waiting for temperature to return to normal (blinks once every five seconds).
	Dark	No power, or DL in sleep mode.
Position	Green	Valid position solution; fine time reference set.
	Green blink	Valid position solution; fine time reference not set.
	Amber	Position fixed; fine time reference set.
	Amber blink	Position fixed; fine time reference not set.
	Red	Insufficient satellites for position.
	Dark	No power, or DL in sleep mode.
Logging	Green	PC Card in, memory capacity OK.
	Green blink	PC Card in, logging to PC Card in progress and memory capacity OK.
	Amber	PC Card in; memory capacity below 10%.
	Amber blink	Logging to PC Card in progress, less than 10% capacity remaining at current logging rate.
	Amber slow blink	Sleeping: waiting for scheduled event (blink once every 5 seconds).
	Red	PC Card in; memory capacity full.
	Red Blink	PC Card in; error encountered while trying to access the PC Card.
	Dark	Power off or PC Card not detected, or initialized.

When the DL is connected to an AC/DC converter, the Power indicator may be ignored as long as the color is green; if it turns red, then you should investigate whether there is a problem with either the AC supply or the converter itself.

3 - USING THE DL

Before using the DL for the first time, ensure that you have followed the installation instructions of *Chapter 2 - Set Up, Page 15*.

⚠ See *CAUTION!, Page 9*, for a list of items of which you should be aware as you use the DL.

SYSTEM BEHAVIOR

SELF-TEST

When power is applied, the DL performs the first phase of self-test functions. If no problems are detected, it enters the power-down mode. Self-test functions are continued when the unit awakes from the power-down mode. Self-test failure of the power data collector module is indicated via front panel indicators and/or MSGA logs. Successful self-test of the power data collector module is indicated by a MSGA log with a BOOTOK message. Self-test status of the MiLLennium GPSCard can then be examined via the self-status word in the RGEA/B/D and RVSA/B data logs.

If the DL fails its self-test, please refer the problem to your dealer or NovAtel Customer Service.

AUTONOMOUS VERSUS HOST CONTROLLED OPERATION

The DL enters the autonomous operation mode whenever it exits the power-down mode (see the table on *Page 25)*. In the autonomous operation mode, upon acquisition of time the DL will execute a group named POWERUP, or if such a group does not exist, stop any current manual logging and enable the scheduler. Execution of the POWERUP group implicitly disables the scheduler.

If a host-controlled mode is desired, the host should enter the POWERUP DISABLE command. This will ensure that autonomous operation mode behavior does not take effect upon acquisition of time.

DEFAULT SCHEDULE AND GROUP CONFIGURATION

The default software configuration for the scheduling and group information includes only a group named "DEFAULT". You must manually add a POWERUP group if this function is desired. Holding down the power switch for approximately 15 seconds restores the factory configuration. All indicator lights flash yellow to indicate that the default configuration has been restored.

NOTE: Only a group named POWERUP is automatically logged. The "DEFAULT" group is provided for your convenience only.

SITE RECORDS IN SCHEDULED (AUTOMATIC) LOGGING SESSIONS

SITELOG logs, described in *Appendix F - DL Logs, Page 64*, contain site record information.

MONITORING YOUR SYSTEM

After the initialization, you may find the following logs useful for observing the DL activities. While using SoftSurv *UTILITIES* is the easiest way to set up these logs (refer to the *SoftSurv User Manual*), you can also use DOS or a Windows-based communications program (see *Appendix J - Command Prompt* Interface, *Page 90*). In the latter case, see

Appendix F - DL Logs, Page 64 or refer to the *MiLLennium Command Descriptions Manual* for procedures and explanations related to data logging and for further information on each of these logs.

- DOPA - reports the dilution of precision of the current satellite constellation
- ETSA - reports the GPS receiver's channel tracking status
- LPSTATUS and MSGA – report DL status messages. For example, the DL monitors the internal temperature of the receiver enclosure. A warning message is issued once per minute when the internal temperature is in excess of a preset threshold. If the internal temperature exceeds the design limit, the DL shuts itself off and stays off until the internal temperature drops 10 degrees below the design limit.
- POSA - reports the current computed position solutions
- RCCA - lists the default command settings. After the DL has been operational for a while, the RCCA log is useful for indicating the status of all current command settings. Displaying the RCCA log after a reset displays the saved configuration; refer to the description of SAVECONFIG in the *MiLLennium Command Descriptions Manual*.
- RVSA - reports the GPS receiver's status
- SATA - reports satellite-specific data

COMMUNICATIONS WITH THE DL

Communication with the DL consists of issuing commands through the COM1 or COM2 serial port from an external serial communications device. This could be either a terminal or an IBM-compatible PC that is directly connected to a DL serial port using a null-modem cable.

For maximum ease, use a user-friendly graphical interface such as SoftSurv *UTILITIES* to configure and communicate with your DL. However, you can also issue commands manually; the DL's command prompt interface is described in *Appendix J, Page 90*. For specific information about any of the DL's commands and logs, please consult *Appendix E - DL Commands, Page 47*, and *Appendix F - DL Logs, Page 64* of this manual.

DATA LOGGING

The most basic activity is logging raw data. Each logging session (one uninterrupted period of time) is stored in a single, unique file on a PC Card. This file can subsequently be transferred to a PC for post-processing using NovAtel's SoftSurv package.

DL records raw data in the form of logs, which are written to the data file on a periodic basis. NovAtel's SoftSurv post-processor automatically interprets these logs and the data that they contain. If you wanted to analyze the data in these logs yourself, the details of the logs are documented in *Appendix F - DL Logs, Page 64* of this manual.

The best way to configure the DL for data logging, or to manipulate log files (e.g. transfer or manage files), is using NovAtel's SoftSurv *UTILITIES*. This software, running on a PC, offers a user-friendly interface to your DL, and allows you to carry out typical activities without having to learn to use the MiLLennium's native-language commands and logs.

A file header is included with each logged data file. This header is designed to expedite post-processing when using NovAtel's SoftSurv post-processor package. The data file's header consists of a GRPA log and a HDRA log (described in detail on *Pages 69* and *71* respectively) which includes the following:

- antenna height
- antenna serial number
- receiver serial numbers
- model numbers
- elevation cutoff
- minimum number of satellites
- start and end time

- log types and rates

Site record logs support kinematic surveying. The site record log (SITELOGA, described in detail on *Page 81*) records this information at each occupation:

- site number, site name, attribute code
- antenna height
- antenna height measurement method code
- site start GPS time
- site end GPS time
- data logging flag

The meteorological log (META, described in detail on *Page 74*) records this information at each occupation:

- GPS time
- data flag
- temperature
- humidity
- pressure
- file offset to previous MET log

SCHEDULE LOGGING OPERATION

Logging can be either immediate or delayed according to a pre-configured schedule which allows both repetitive events (for example, every day from 15:00 to 17:00) and custom events (for example, tomorrow from 10:00 to 11:00, and the day after from 17:00 to 18:00). If a session is predefined or a manual session is started, a new file opens and the initial file closes.

You can schedule data logging on up to seven days in a one-week period, with up to 36 sessions per day. The scheduler operates perpetually; i.e. if an event is scheduled to occur on a Monday, this event is serviced every Monday that the system is in operation. Start and stop times must be provided with a resolution of 1 minute. The minimum time interval per logging session is 5 minutes. If you do not provide file names in advance, a unique file name is automatically generated for each set of recorded logs. Only one schedule can be active at any time. If there is sufficient time between sessions, the DL will go into “sleep” mode to conserve power.

You may not specify overlapping time intervals. All scheduled entries rely on day of the week and UTC time references.

FILE NAME CONVENTION

You can either provide a name for each data file in advance, or allow DL to generate them automatically.

You can only provide a file name when you are scheduling a single data collection event. If you are scheduling a series of events, you have to accept the DL’s auto-generated names. An acceptable file name consists of a base of up to eight characters, followed by a .PDC extension. The first character of the name that you specify cannot be numeric; this prevents conflicts with auto-generated names, which always start with a number.

Auto-generated filenames consist of an eight-character base followed by a .PDC extension. The eight characters are derived as shown in *Table 5* on the following page:

Table 5: Auto-Generated File Name Convention

####$$$%.PDC	Comments
####	last 4 digits of the DL's serial number
$$$	UTC day of the year (001 – 366)
%	Session ID assigned in sequence (0 .. 9, A .. Z) based on the presence of files previously logged on a particular day.

For example, a DL might have a serial number such as CGN95450087. A date such as January 25 has an UTC day-of-year representation of 025. The 15th schedule of the day would have an entry index of E. Thus, this file would have a name such as 0087025E.PDC.

Should a conflict occur between an auto-generated file name or a file name specified in a scheduled entry, the DL will resolve the conflict by creating a file name whose first character is a tilde ("~"), followed by a 7-digit random number, and a .PDC extension (e.g. ~9368412.PDC).

DATA STORAGE REQUIREMENTS

Based on default settings (using RGED logs for observations, and PRTKB logs for positions), *Table 6* displays the amount of data storage required for a single data record for scenarios of 6, 9, or 12 satellites in view.

Table 6: Storage Requirements per Data Record

	L1-only		L1 & L2	
	Single-point Observations (Bytes)	Single-point or Differential Observations & Positions (Bytes)	Single-point Observations (Bytes)	Single-point or Differential Observations & Positions (Bytes)
6 SV	144	268	264	388
9 SV	204	328	384	508
12 SV	264	388	504	628

The number in a specific cell in this table represents the memory consumption (in bytes) per recorded GPS point, for a given number of visible satellites and a given recording mode. The following relationship, based on *Table 6*, yields an estimate of the data storage requirements for a data-recording session:

- ***Minimum file size (in bytes) ≈ (bytes per record) x (records per hour) x (number of hours)***

This is an approximation - the actual file size will be a few kilobytes larger, due to file headers and other information (e.g. satellite ephemeris and almanac data). Also, feature tagging increases the file size by an amount that depends on the number of features tagged, and the number of attributes for each feature.

Example from Table 6:

You wish to record single-point observations, once every 2 seconds, for 8 hours, with 9 satellites visible, during L1/L2 operation. The file size will be no less than (384 bytes/record) x (1800 records/hour) x (8 hours) = 5,529,600 bytes = 5529.6 kBytes ≈ 5.3 MBytes. At this rate, a 20 MByte PC Card could hold approximately 30 hours of data.

Based on the values in *Table 6*, one can calculate how much data is generated in one hour if the RGED and PRTKB logs are collected every two seconds. This is the typical data-logging rate for real-time kinematic (RTK) survey applications. The cells of *Table 7* reflect the memory consumption, in kilobytes per hour, for scenarios of 6, 9, or 12 satellites in view.

Table 7: Memory Consumption – Typical Case for RTK Survey (2 Second Rate)

	L1-only		L1 & L2	
	Single-point Observations (kBytes/hour)	Single-point or Differential Observations & Positions (kBytes/hour)	Single-point Observations (kBytes/hour)	Single-point or Differential Observations & Positions (kBytes/hour)
6 SV	253	471	464	682
9 SV	359	577	675	893
12 SV	464	682	886	1104

The following relationship, based on *Table 7*, yields an estimate of the data storage requirements for a typical RTK data-recording session:

- ***Minimum file size (in kilobytes) ≈ (kilobytes per hour) x (number of hours)***

Example from Table 7:

You wish to record single-point observations, once every 2 seconds, for 8 hours, with 9 satellites visible, during L1/L2 operation. The file size will be no less than (675 kBytes/hour) x (8 hours) = 5400 kBytes = 5.4 MBytes. At this rate, a 20 MByte PC Card could hold approximately 30 hours of data.

Based on the values in *Table 6*, one can calculate how much data is generated in one hour if the RGED and PRTKB logs are collected every 15 seconds. This is the typical data-logging rate for static survey (post-processing) applications. The cells of *Table 8* reflect the memory consumption, in kilobytes per hour, for scenarios of 6, 9, or 12 satellites in view.

Table 8: Memory Consumption – Typical Case for Static Survey (15 Second Rate)

	L1-only		L1 & L2	
	Single-point Observations (kBytes/hour)	Single-point or Differential Observations & Positions (kBytes/hour)	Single-point Observations (kBytes/hour)	Single-point or Differential Observations & Positions (kBytes/hour)
6 SV	34	63	62	91
9 SV	48	77	90	119
12 SV	62	91	118	147

The following relationship, based on *Table 8*, yields an estimate of the data storage requirements for a typical data-recording session intended for post-processing:

- ***Minimum file size (in kilobytes) ≈ (kilobytes per hour) x (number of hours)***

Example from Table 8:

You wish to record differential observations and positions, once every 15 seconds, for 8 hours, with 9 satellites visible, during L1/L2 operation. The file size will be no less than (119 kBytes/hour) x (8 hours) = 952 kBytes ≈ 0.9 MBytes. At this rate, a 20 MByte PC Card could hold approximately 177 hours of data.

ERRORS

The data logging mechanism is designed to be robust and to endure power interruptions (and similar disruptive events) with minimum loss of data. In these situations, less than 5 minutes of data (prior to the disruptive event) are lost. To the extent possible, error messages (see the description on MSGA log on page 75) attempt to describe the problem.

4 - FIRMWARE UPGRADES & UPDATES

The DL includes two distinct processors in its enclosure:

- a GPS receiver (MiLLennium GPSCard)
- an integrated power supply and data controller (PDC card)

Each of these components has its own microprocessor, and each microprocessor has its own firmware (program software), which is stored in non-volatile memory. What makes one DL model different from another is software, not hardware. This unique feature means that upgrading the firmware is equivalent to getting a DL with an entirely different set of features! This can be done anytime, anywhere, without any mechanical procedures whatsoever. New firmware can be transferred to the DL through a serial port, immediately making the unit ready for operation at a higher level of performance. This also prevents rapid obsolescence.

The first step in upgrading your receiver is to contact your dealer or NovAtel Customer Service as described in *Customer Service, Page 8*. When you call, be sure to have available your DL model numbers, serial numbers, and program revision levels. You can obtain this information by generating HDRA and PSNA logs.

After establishing which new model/revision level would best suit your needs, and having discussed the terms and conditions, your dealer or NovAtel Customer Service will issue to you the authorization code ("auth-code") which is required to unlock the desired new features.

The following sections will assist you in this procedure. Go to the appropriate section, depending on whether you are dealing with the GPS receiver or the PDC card.

UPGRADE OR UPDATE THE MILLENNIUM GPSCARD

There are two procedures to choose from, depending on the type of upgrade/update you require:

1. If you are ***upgrading*** to a higher performance model at the same firmware revision level (e.g. upgrading from a MiLLennium Standard rev. 4.50, to a MiLLennium RT-2 rev. 4.50), you can use the $AUTH special command.
2. If you are ***updating*** to a higher firmware revision level of the same model (e.g. updating a MiLLennium Standard rev. 4.50 to a higher revision level of the same model), you need to transfer new program firmware to the MiLLennium using the *Loader* utility program. As the *Loader* and update programs are generally provided in a compressed file format, you will also be given a file decompression password. The *Loader* and update files can be found on NovAtel's FTP site, or can be sent to you on floppy disk or by e-mail.

These procedures are described more completely in this chapter.

UPGRADING USING THE $AUTH COMMAND

The $AUTH command is a special input command which authorizes the enabling or unlocking of the various model features. Use this command when upgrading to a higher performance MiLLennium model available within the same revision level as your current model (e.g., upgrading from a MiLLennium Standard rev. 4.50, to a MiLLennium RT-2 rev. 4.50). This command only functions in conjunction with a valid auth-code.

The upgrade can be performed directly from Loader's built-in terminal emulator, or any other communications software. The procedure is as follows:

1) Turn on the DL and establish communications over a serial port (see *Communications with the DL, Page 28*)
2) Issue the VERSION command to verify the current firmware model number, revision level, and serial number.
3) Issue the $AUTH command, followed by the auth-code and model type. The syntax is as follows:

Syntax:

$AUTH auth-code

where

$AUTH	is a special command that allows program model upgrades
auth-code	is the upgrade authorization code, expressed as *hhhh,hhhh,hhhh,hhhh,hhhh,model#* where the *h* characters are an ASCII hexadecimal code, and the *model#* would be ASCII text

Example:

```
$auth 17cb,29af,3d74,01ec,fd34,millenrt2
```

Once the $AUTH command has been executed, the MiLLennium resets itself. Issuing the VERSION command produces a response confirming the new upgrade model's type and version number.

UPDATING USING THE "LOADER" UTILITY

Loader is required (instead of the $AUTH command) when updating previously released firmware with a newer version of program and model firmware (e.g., updating a MiLLennium Standard rev. 4.50 to a higher revision level of the same model). *Loader* is a DOS utility program designed to facilitate program and model updates. Once *Loader* is installed and running, it allows you to select a host PC serial port, bit rate, directory path, and file name of the new program firmware to be transferred to the MiLLennium.

Acquire Firmware Files

You must first acquire the latest firmware revision, which comes as a file with a name such as OEMXYZ.EXE (where XYZ is the firmware revision level). This file is available from NovAtel's FTP site (ftp.novatel.ca), or via e-mail (support@novatel.ca). Alternately, the file can be mailed to you on floppy disk.

At least 1 MB of space should be available on the PC's hard drive. For convenience, you may wish to copy this file to a GPS sub-directory (e.g., `C:\GPS\LOADER`).

The file is available in a compressed format with password protection; you will receive the required password. After copying the file to your computer, it must be decompressed. The syntax for decompression is as follows:

Syntax:

filename -s[password]

where

filename	is the name of the compressed file (but not including the .EXE extension)
-s	is the password command switch
password	is the password required allowing decompression

Example:

```
oem442 -s12345678
```

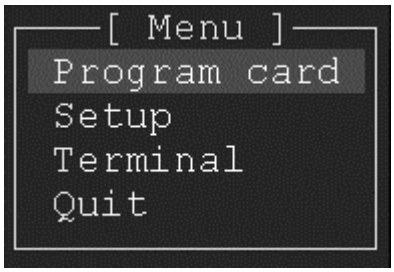
The self-extracting archive then generates the following files:

- LOADER.EXE *Loader* utility program
- LOADER.TXT Instructions on how to use the *Loader* utility
- XYZ.BIN Firmware version update file, where XYZ = program version level (e.g. 442.BIN)

Run "Loader"

The *Loader* utility can operate from any DOS directory or drive on your PC. The program is comprised of three parts: *Program Card* (authorization procedure), *Setup* (communications configuration) and *Terminal* (terminal emulator). The choices on the main screen are shown in *Figure 9* below:

Figure 9: LOADER Options

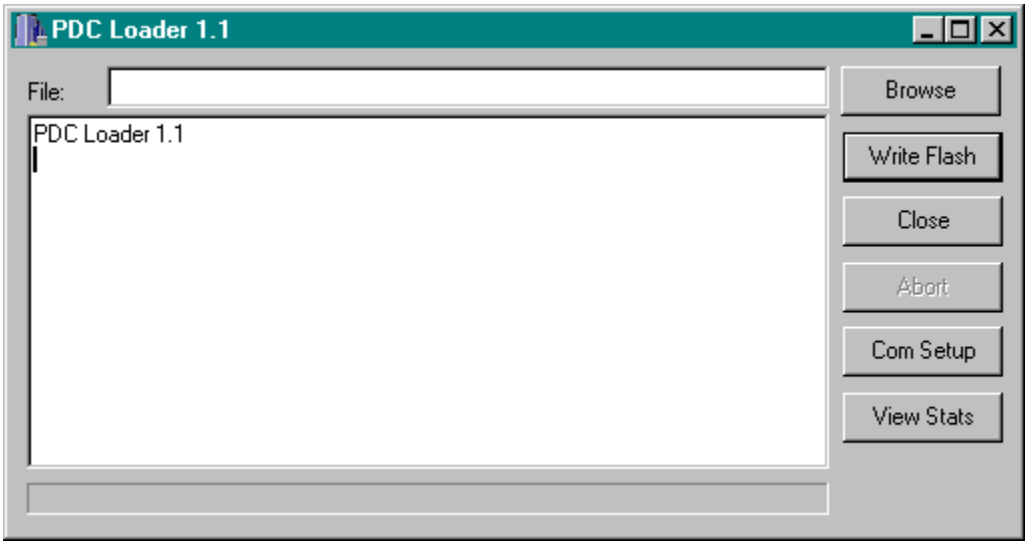


If you are running *Loader* for the first time, be sure to access the *Setup* menu (step 3 below) before proceeding to *Program Card* (step 4 below); otherwise, you can go directly from step 2 below to step 4. The procedure is as follows:

1. Turn off the DL.
2. Start the *Loader* program.
3. From the main menu screen, select **`Setup`** to configure the PC serial port over which communication is to occur (default: COM1), and the data transfer rates for both programming (default: 115 200 bits per second) and terminal emulation (default: 9600 bps). To minimize the time required, select the highest serial bit rate your PC can reliably support. *Loader* verifies and saves your selections in a file named LOADER.SET, then returns to the main menu screen.
4. From the main screen, select **`Program Card`**.
5. Select the disk drive (e.g., A, B, C, D) in which the update file (e.g. `442.BIN`) is located. Select the path where the update program file is located (e.g., `C:\GPS\LOADER`); the directory from which you started *Loader* is the default path. Select the required update file (e.g. `442.BIN`).
6. At the prompt, enter your update auth-code (e.g. `17b2,32df,6ba0,92b5,e5b9,millenrt2`).
7. When prompted by the program, turn on the DL. *Loader* automatically establishes communications with the DL. The time required to transfer the new program data depends on the bit rate which was selected earlier.
8. When the transfer is complete, use the terminal emulator in *Loader (*select **`Terminal`***)*, or any other one, to issue the VERSION command; the response serves to verify your new program version number. When using the terminal emulator in *Loader*, a prompt does not initially appear; you need to enter the command first, which then produces a response, after which a prompt appears.
9. Exit *Loader* (select **`Quit`**).

This completes the procedure required for field-updating a MiLLennium.

UPGRADE OR UPDATE THE PDC CARD



Ensure your PC and DL are properly connected, see *Setting Up At The Office, Page 15*. The serial data cable should go from any COM port on the PC to COM2 on the DL. Have all power cables in place but do not turn on the DL just yet. Power the DL using the AC adapter. Do not use batteries, as power interruptions during the process may damage the DL, see the warning below.

Execute PDCLOAD.exe in Windows. A PDC Loader dialog will appear. Click on the Browse button to bring up a file browser in order to locate the update/upgrade file to be downloaded to the DL's PDC card.

Once the appropriate file has been selected, check your COM setup by clicking on the Com Setup button. Choose the COM port and then the highest baud rate that your PC and DL can handle. Click OK.

Turn on the DL. As soon as the Power indicator light on the front of the DL becomes red, click once on the Write Flash button in the PDC Loader dialog on your PC.

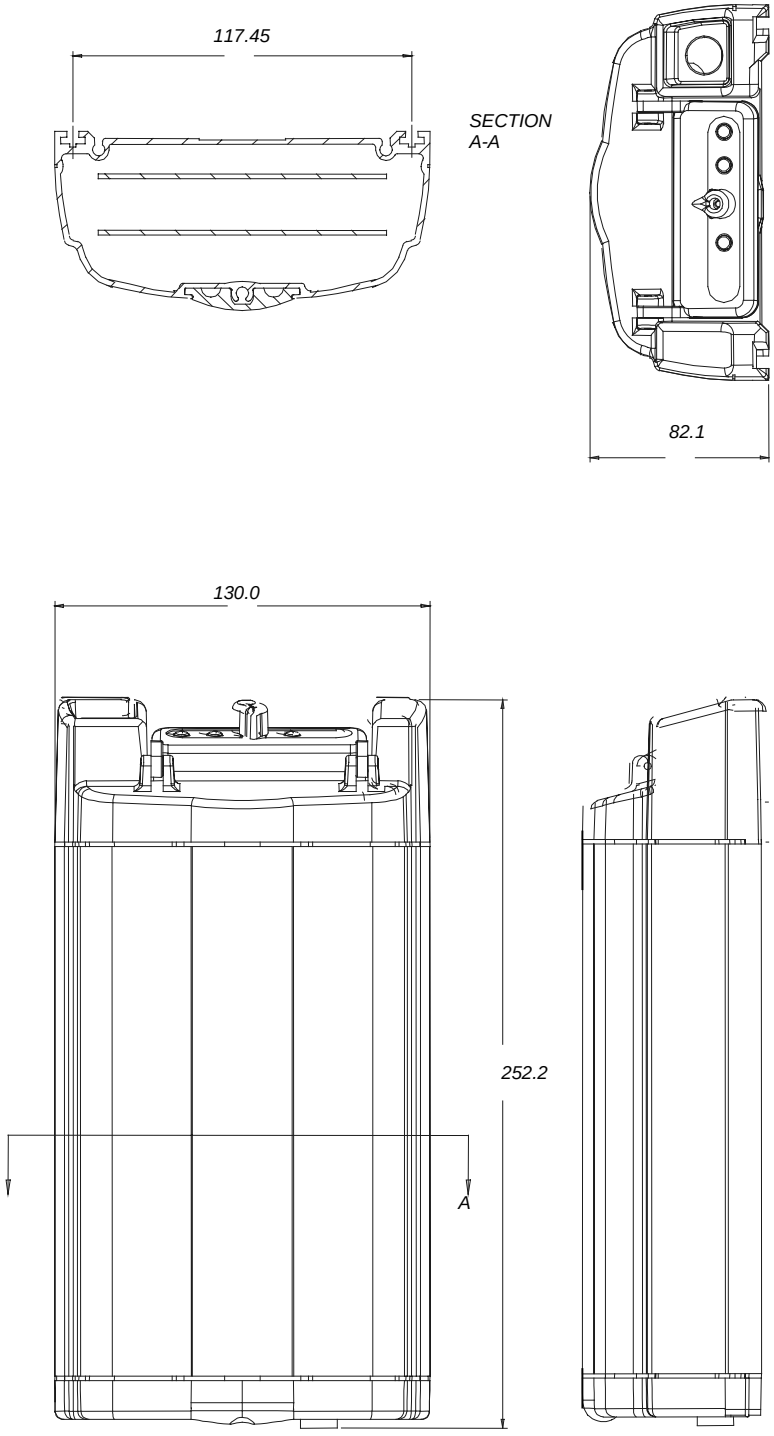
A progress bar will appear in the PDC Loader dialog, shown above. The display box in this dialog will show a list of what is happening as it happens. If you wish to see more information, click on the View Stats button. When Loader is finished the last line will tell you whether or not the download was successful.

Please contact your local NovAtel dealer or NovAtel Customer Service, see *CUSTOMER SERVICE, Page 8*, for more information on how to upgrade or update the PDC card in your DL.

WARNING: **Do not turn off power to the DL or PC until this process is completed. If you do turn off power before Loader is finished, the DL may have to be returned to NovAtel for repair.**

APPENDIX A - DL DRAWINGS

Figure 10: Views



All dimensions are expressed as millimeters.

APPENDIX B - DL SPECIFICATIONS

PHYSICAL	
Size	245 mm x 130 mm x 59 mm
Description of Enclosure	The enclosure is constructed of extruded anodized aluminum. It is sealed by two end-caps, made of molded ABS plastic. The entire unit is closed with five mounting screws. An access cover on the front end-cap allows the insertion and removal of PC Cards. Seals are made of electrically conductive rubber.
Weight	1.5 kg
ENVIRONMENTAL	
Operating Temperature	-40° C to +55° C
Storage Temperature	-40°C to +85°C
Resistance Characteristics	Dust and water resistant
Humidity	5% to 95% RH (non-condensing) at +40°C
Altitude	Sea level to 5,000 m [may operate above 5,000 m in a controlled environment, however is not certified as such.]

VIBRATION (Random Profile)

The DL can acquire and track satellites while undergoing vibration levels as shown below. It assumes that C/No > 45 dB-Hz and that the DL is in high-dynamics mode. Assuming appropriate mounting, the DL conforms to random vibration templates for RTCA/DO-160C, Section 8.6.2 (Curve C template), MIL-STD-202F, Test Condition I (Letter A nominal template), and ASAE EP455, Section 5.15.1 nominal template; contact your dealer or NovAtel Customer Service for information on the effect of the mounting bracket.

Frequency	< 10 Hz	10 Hz	40 Hz	1000 Hz	2000 Hz	> 2000 Hz
Magnitude (g2/Hz)	+ 80 dB/decade	0.00125	0.02	0.02	0.005	- 80 dB/decade

ACCELERATION (DYNAMICS)	
Acceleration	6g maximum (sustained tracking)
POWER REQUIREMENTS	
Voltage	+10.7 to +18 V DC
Power	11 W (typical while logging), 0.25 W (sleep mode)
PERIPHERAL POWER OUTPUT	
Voltage	≅ supplied voltage
Current	≤ 2 A (internal fuse), non-user replaceable

POWER MANAGEMENT

If the DL is connected to two batteries, it begins using the one with the higher voltage across its terminals. When this voltage drops to 10.7 V DC, the Power indicator color changes from green to amber. When the voltage drops below 10.0 V DC, the battery is unusable; the Power indicator color changes from amber to red, and the DL switches to the second battery (if available). Once battery reserves are depleted, the DL shuts itself off.

REAL-TIME CLOCK
A real-time internal clock allows the DL to go into low-power "sleep mode" between scheduled data-collection sessions. When the DL is turned on, this clock is initialized using the GPS time reference, and will indefinitely maintain an accuracy of ±1 second and a resolution of 1 second. When the DL is turned off, the clock begins to drift. To compensate for this drift, the DL emerges from sleep mode in advance of the next scheduled data-collection session in order to re-initialize itself.

PERFORMANCE *(Subject To GPS System Characteristics)*	
Frequency	1575.42 MHz (L1) & 1227.60 MHz (L2)
Codes tracked	C/A & P codes
Channels	12 L1/L2 channel pairs, or 12 L1-only (depending on model)
Time to First Fix	100 s (95% probability) 70 s typical (cold start: no initial time or almanac)
Re-acquisition	L1: 3 s typical L2: 10 s typical
Computed Data Update Rate	5 solutions per second
Measured Data Update Rate	10 data records per second
Position Accuracy	**Stand-alone:** 40 m CEP (SA on, GDOP < 2) **Differential:** Without choke ring, GDOP < 4: CEP < 1.25 m, SEP < 1.85 m With choke ring, GDOP < 4: CEP < 0.75 m, SEP < 1.00 m **RT-2 differential:** 2 cm ± 1 ppm baseline CEP **L1/L2 post-processing differential:** 2 cm ± 1 ppm baseline CEP
Position Latency	175 ms
Pseudorange Code Measurement Accuracy	C/A code phase = 10 cm RMS with C/N_0 > 42.0 dB-Hz P code phase = 40 cm RMS with C/N_0 > 36.0 dB-Hz
Velocity Accuracy	0.03 m/s nominal (differential); 0.20 m/s nominal (single point)
Single Channel Carrier Phase Measurement Accuracy	L1 carrier phase = 3 mm RMS, C/N_0 > 42.0 dB-Hz L2 carrier phase = 5 mm RMS, C/N_0 > 36.0 dB-Hz
Differential Channel Carrier Phase Measurement Accuracy	L1 carrier phase = 0.75 mm RMS, 1 s smoothed, C/N_0 > 42.0 dB-Hz L2 carrier phase = 4.0 mm RMS, 1 s smoothed, C/N_0 > 36.0 dB-Hz
RT-20	The RT-20 system uses pseudorange and carrier-phase double differencing to provide nominal 20-cm accuracy (CEP) after 5 minutes of continuous lock (in static mode, on a 100 m baseline). After an additional period of continuous tracking (from 10 to 20 minutes), the system reaches steady state and position accuracies in the order of 3 to 4 cm are typical. The time to steady state is about 3 times longer in kinematic mode. These double-difference accuracies are based on PDOP < 2 and continuous tracking of at least 5 satellites (6 preferred) at elevations of at least 11.5°. All accuracy values refer to horizontal RMS error, and are based on low-latency positions. The level of position accuracy at any time will be reflected in the standard deviations output with the position.

PERFORMANCE *(Subject To GPS System Characteristics)*		
RT-2	Pseudorange & carrier-phase double differencing (fixed < 2 cm RMS accuracies with RTK carrier-phase positioning). Conditions: <10 km baseline length; ≥ 6 satellites at an elevation > 12°; after 2 minutes convergence; with choke-ring ground plane at base station.	
Time Accuracy (relative)	250 ns (SA on) – does not include delays due to cable on RF section	
Height Limit	Up to 18,288 m (60,000 feet), in accordance with export licensing	
Velocity Limit	Up to 515 m/s (1000 Nmi/hr), in accordance with export licensing	
RF INPUT / LNA POWER OUTPUT		
Connector on DL	Standard 50 Ω TNC female type	
RF Input	1575.42 MHz, 1227.60 MHz	
Power Output to LNA	4.25 - 5.25 V DC @ 0 - 90 mA. ***Note:*** if the antenna draws current above this limit, power to the antenna is disabled and the antenna self-test status flag is set to zero. Refer to the documentation for the RVSA log for more information.	
INPUT/OUTPUT DATA INTERFACE		
Dual RS-232C Serial	Bit rates: 300, 1200, 4800, 9600, 19200, 57600, 115200 bps (9600 bps default)	
Signals supported	TX, RX, RTS, CTS, DTR, DSR, DCD	
Electrical format	EIA RS232C Standard	
INPUT/OUTPUT STROBES		
VARF Output	A programmable variable frequency output ranging from 0 - 5 MHz (refer to FREQUENCY_OUT command), with pulse width = 1 ms. This is a normally high, active low pulse. There may be as much as 50 ns jitter on this signal.	
PPS Output	A one-pulse-per-second time synchronization output. This is a normally high, active low pulse (1 ms ± 50 ns) where the falling edge is the reference.	
Measure Output	4 pulses-per-second output, normally high, active low where the pulse width is 1 ms. The falling edge is the receiver measurement strobe.	
Mark Input	An input mark (negative pulse > 55 ns), time tags output log data to the time of the falling edge of the mark input pulse (refer to LOG command syntax – ONMARK).	
Status Output	Indicates a valid GPS position solution is available. A high level indicates a valid solution or that the FIX POSITION command has been set.	
The electrical specifications of the strobe signals are as follows:		
Output	Voltage:	Standard TTL levels
	Sink Current:	64 mA
	Source Current:	15 mA
Input	Voltage:	Standard TTL levels
	Current:	≤ 5 mA

APPENDIX C - PC CARD SPECIFICATIONS

PC CARD SOCKET

The socket on the DL accommodates one Type II or Type III PC Card. The socket specification conforms to the PC Card Standard release 2.1+, except that 12 V operation and programming is not supported. Only 3.3 V and 5 V operation and programming are supported.

PC CARD

The memory card socket is compatible with a Type II PC Card ATA mass storage card, and has been tested with 4 MB, 20 MB, 40 MB and 85 MB PC Cards. Please contact your local NovAtel dealer, or the NovAtel Customer Service Department (see

CUSTOMER SERVICE on *Page 8*), for a list of supported PC Cards. You can also obtain memory cards directly from NovAtel, please see *Appendix H - Replacement* Parts on *Page 87*.

An industrial temperature grade PC Card is recommended for operation within the full DL operating temperature range. More information is also available from your local NovAtel dealer, or the NovAtel Customer Service Department.

APPENDIX D - PORT & CABLE PINOUTS

POWER

POWER CONNECTOR

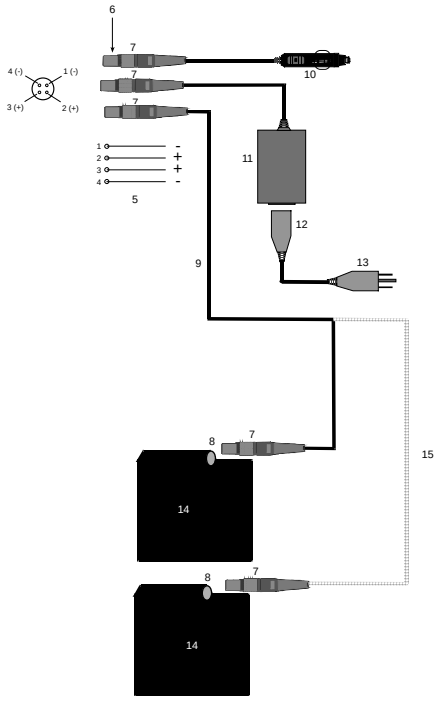
The power connector on the DL is a LEMO HGM.0B.304.CLAP, with the pins assigned as shown in the following table. The two possible independent power sources are designated A and B:

Table 9: Power Connector Pin Assignment

Battery A		Battery B	
Pin	**Description**	**Pin**	**Description**
1	Negative Supply A Input	3	Positive Supply B Input
2	Positive Supply A Input	4	Negative Supply B Input

POWER CABLES

Figure 10: Power Cables



Reference	Description	Reference	Description
1	Brown (GND)	9	Optional power cable (33.5 cm or 75 cm)
2	Orange (+10.7 to +18 V DC)	10	Automotive cigarette-lighter adapter with 3-amp slow-blow fuse
3	Red (+10.7 to +18 V DC)	11	Auto-ranging AC/DC converter/battery charger
4	Black (GND)	12	AC socket
5	4 conductor cable	13	AC plug
6	Red marker at top of connector	14	Battery
7	Female LEMO plug	15	Optional Y cable
8	Male LEMO socket		

DATA COMMUNICATIONS

SERIAL PORT CONNECTORS

The two serial ports (COM1 and COM2) on the DL use LEMO EEG.IK.310.CLN sockets, with the pins assigned as given in *Table 10: COM2 Serial Port - Connector Pin Assignment* and *Table 11: COM1 Serial Port - Connector Pin Assignment*:

Table 10: COM2 Serial Port - Connector Pin Assignment

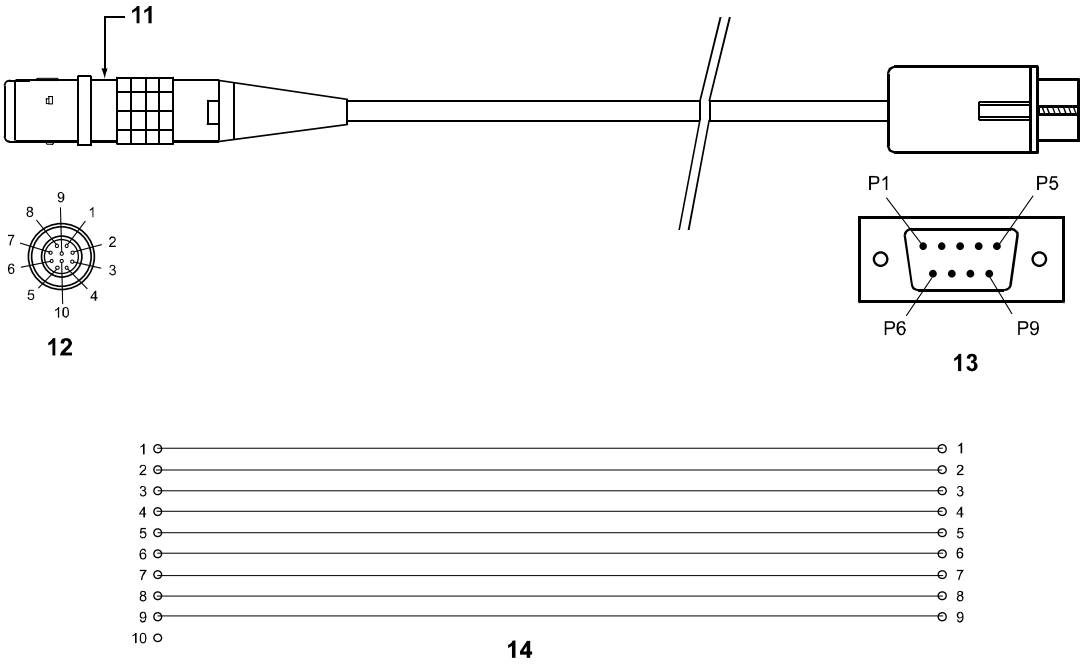
Pin	Name	Description
1	DCD	Data Carrier Detect input
2	RXD	Receive Data input
3	TXD	Transmit Data output
4	GND	Battery return
5	GND	Signal ground
6	-	No Connection
7	RTS	Ready to Send output
8	CTS	Clear to Send input
9	BAT	Battery
10	N/C	N/C

Table 11: COM1 Serial Port - Connector Pin Assignment

Pin	Name	Description
1	DCD	Data Carrier Detect input
2	RXD	Receive Data input
3	TXD	Transmit Data output
4	DTR	Data Terminal ready
5	GND	Signal ground
6	DSR	Data Set ready
7	RTS	Ready to Send output
8	CTS	Clear to Send input
9	NULL	NULL
10	N/C	N/C

STRAIGHT SERIAL CABLE

Figure 11: Straight Serial Cable - Illustration



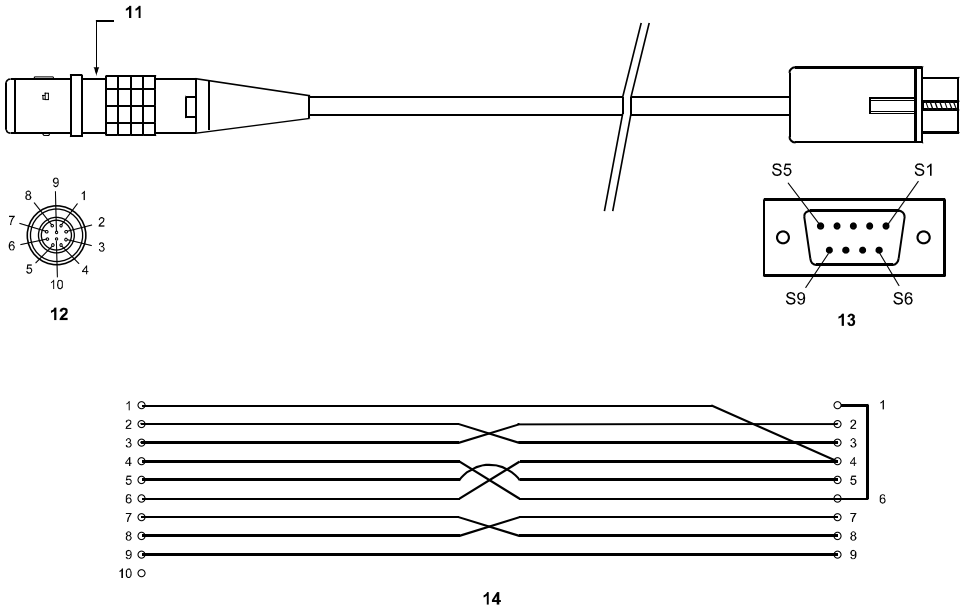
Reference	Description	Reference	Description
1	Brown	8	Violet
2	Black	9	Grey
3	Red	10	White
4	Orange	11	Red marker at top of connector
5	Yellow	12	Male LEMO 10-pin plug
6	Green	13	DE9P (male)
7	Blue	14	10-conductor cable

Table 12: Straight Serial Cable - Pin Assignment

LEMO Pin No.	RS232C Signal COM1	RS232C Signal COM2	Wire Color Code	DE9P Pin No.
Pin 1	DCD	DCD	Brown	Pin 1
Pin 2	RXD	RXD	Black	Pin 2
Pin 3	TXD	TXD	Red	Pin 3
Pin 4	DTR	GND	Orange	Pin 4
Pin 5	GND	GND	Yellow	Pin 5
Pin 6	DSR	DSR	Green	Pin 6
Pin 7	RTS	RTS	Blue	Pin 7
Pin 8	CTS	CTS	Violet	Pin 8
Pin 9	NULL	BAT	Grey	Pin 9
Pin 10			White (Not used)	

NULL-MODEM SERIAL CABLE

Figure 12: Null-Modem Serial Cable - Illustration



Reference	Description	Reference	Description
1	Brown	8	Violet
2	Black	9	Grey
3	Red	10	White
4	Orange	11	Red marker at top of connector
5	Yellow	12	Male LEMO 10 pin plug
6	Green	13	DE9S (female)
7	Blue	14	10-conductor cable

Table 13: Null-Modem Cable - Pin Assignment

LEMO Pin No.	RS232C Signal COM1	RS232C Signal COM2	Wire Color Code	DE9S Pin No.
Pin 1	DCD	DCD	Brown	Pin 4
Pin 2	RXD	RXD	Black	Pin 3
Pin 3	TXD	TXD	Red	Pin 2
Pin 4	DTR	GND	Orange	Pin 6
Pin 5	GND	GND	Yellow	Pin 5
Pin 6	DSR	DSR	Green	Pin 4
Pin 7	RTS	RTS	Blue	Pin 8
Pin 8	CTS	CTS	Violet	Pin 7
Pin 9	NULL	BAT	Grey	Pin 9
Pin 10			White (Not used)	Pin 1 jumpered to Pin 6

INPUT / OUTPUT

I/O CONNECTOR

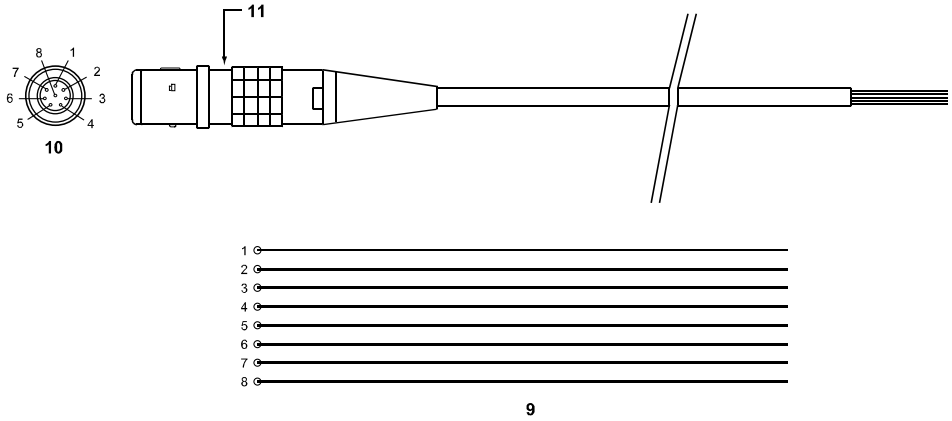
The input/output (I/O) port on the DL uses a LEMO EEG.1K.308.CLN double-keyed socket, with the pins assigned as given in the following table:

Table 14: I/O Connector Pin Assignment

Pin	Name	Description
1	VARF	Variable frequency output: a user-programmable, variable-frequency sequence of pulses
2	1PPS	Pulse per second output: a 1 ms pulse repeating at a 1 Hz rate that is used to synchronize the board with external devices.
3	MSR	Measure Output
4	MKI	Mark input: this signal provides a time tag to the signal processors, which respond to a falling edge of the signal provided from an external device. It can be enabled by the user to provide a precise time and data output event.
5	STATUS	Status output: an output that changes logic states when a valid GPS position is obtained by the GPSCard
6	GND	Signal ground
7	GND	Signal ground
8	GND	Signal ground

I/O CABLE

Figure 13: I/O Cable - Illustration

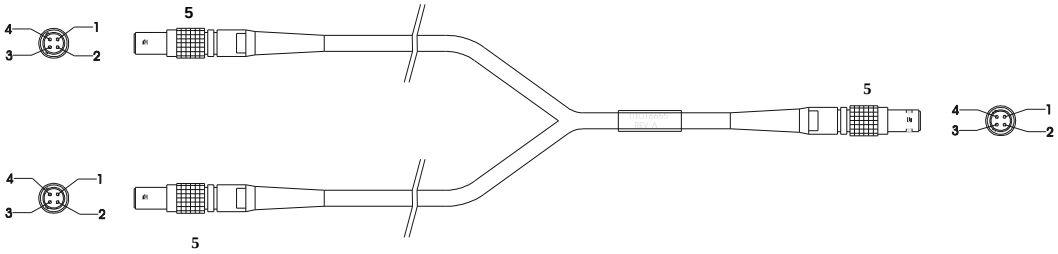


Reference	Description	Reference	Description
1	Brown	7	Blue
2	Black	8	White
3	Red	9	8 conductor cable
4	Orange	10	Female LEMO 8-pin plug
5	Yellow	11	Red marker at top of connector
6	Green		

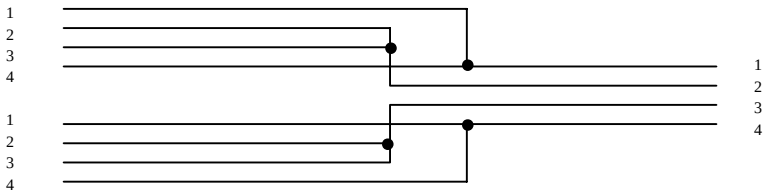
Table 15: I/O Cable – Pin Assignment

LEMO Pin Number	Pin Description	Wire Color Code
Pin 1	VARF, variable frequency	Brown
Pin 2	1 PPS, one pulse per second	Black
Pin 3	MSR, measure output	Red
Pin 4	MKI, mark input	Orange
Pin 5	STATUS , valid solutions available	Yellow
Pin 6	GND	Green
Pin 7	GND	Blue
Pin 8	GND	White

Y CABLE



Reference	Description	
1	Brown	(-ve)
2	Orange	(+ve)
3	Red	(+ve)
4	Black	(-ve)
5	Female LEMO Plug	



APPENDIX E - DL COMMANDS

The DL firmware implements the following commands in addition to the MiLLennium GPSCard command set.

Command	Description
battery	Control battery source
del	Remove stored logs from memory
dir	Display stored log summary information
dump	Transfer stored logs to host
group	Modify log group definitions
loggroup	Manual group logging control
mets	Enter meteorological information
pdc	Logs PDC parameters, PDC factory reset
powerup	Default operation mode control
project	Project-related parameters
psn	Retrieve system serial numbers
pversion	Retrieve PDC serial, version and model numbers
rename	Rename a file stored in PC Card module
schedule	Modify the logging schedule
site	Site record interface
sleep	Enable low-power mode
status	Return system status information
vout	Control peripheral power output
write	Write data to a specified file on the PC Card

The arguments to each of these commands are described in the following sections.

For a complete listing and description of the other commands that the DL is capable of processing, please consult the *MiLLennium GPSCard Command Descriptions Manual*.

NOTE: At the command prompt, type <HELP> or <help> to get online help about the various commands.

SYNTAX CONVENTIONS

The following rules apply when entering commands, at the command prompt, from a keyboard.

1. The commands are not case sensitive. For example, you could type either <`BATTERY A`> or <`battery a`>.
2. Except where noted, either a space or a comma can separate commands and their required entries. For example, you could type either <`group del alpha p20a`> or <`group,del,alpha,p20a`>.
3. At the end of a command, a carriage return is required. For example, press <Enter> or <Return>.
4. Most command entries do not provide a response to the entered command. There are exceptions to this statement, for example the VERSION and HELP commands. Otherwise, successful entry of a command is verified by receipt of the serial port prompt (i.e. COM1> or COM2>).
5. Optional parameters are indicated by square brackets.
6. `Courier font` is used to illustrate program output or user input.

BATTERY

This command allows you to select the power source for the system and display battery status. For example, you can override the DL's method of selecting the active battery, when two batteries are connected. To do this the desired battery identifier (A or B) must be specified in the command. Also see *Table 9: Power Connector Pin Assignment, Page 41*.

Syntax:

BATTERY [*option*]

Command	Option	Description
BATTERY	-	Command
option	(none)	If no battery is specified, the status of the currently selected battery is displayed via a BATA log.
	a	Select power source A.
	b	Select power source B.

Examples:

```
battery
battery b
```

DEL

This command removes one or more files from the list of stored files on the PC Card. The space occupied by the referenced file(s) is made available for future logging sessions. This operation is irreversible.

Syntax:

DEL [option]

Command	Option	Description
DEL	-	Command
option	filename	This command removes the named file entry from the list of stored log files. If the specified file is currently open for logging, access will be denied.
	ALL	This command removes all file entries from the log storage memory. Even in the case where a file named 'all' exists, this command still removes all file entries. This command will fail if a log file is open.

Examples:

```
del 31240201.pdc
del all
```

DIR

This command either displays a list of stored files on the PC Card, or the file header information for the specified log file. It also displays additional group information when it has been supplied as part of a group definition.

Syntax:

```
DIR [option]
```

Command	Option	Description
DIR	-	Command
option	(none)	If no filename is specified, this command displays a list of stored files using the DIRA log. The final entry returned by this command displays the logging memory available as the size of a file named 'FREEMEM'.
	filename	When invoked with a *filename* argument, this command displays the file header information for the specified log file using a HDRA log followed by a GRPA log or a GROUPA log if the group contains information which cannot be displayed with the GRPA log. Finally a PROJECTA log is displayed if project information has been given using the PROJECT command. An error message is displayed if the file does not exist.

Examples:

```
dir
dir 31240201.pdc
```

DUMP

This command displays the contents of the named file. Header information precedes the actual logged data.

Syntax:

```
DUMP filename
```

Example:

```
dump 31240201.pdc
```

GROUP

This command is used to maintain a set of log specifiers that would normally be used together in a specific scenario, e.g. for base-station logging. Up to ten groups can be defined. The group name can be up to nine characters in length. If a group named "POWERUP" is defined, this group's log specification is executed when the DL determines what time it is, after the DL is turned on. In that case, any other scheduled activity would be excluded.

There are four major syntactical forms, as shown below.

Syntax 1:

This command is used to display information about one or more existing groups.

GROUP *[option]*

Command	Option	Description
GROUP	-	Command
option	(none)	Entered without arguments, this command displays the current groups as a set of GRPA logs, followed by MSGA with Code=3001, Error=CMDFAIL, SubCode=1001, SubCodeMsg=ENDGRPLIST.
	group name	If a valid group name (e.g. "alpha") is given as an argument, only that log group is displayed. The display is as described above.

Examples:

```
group
group alpha
```

***NOTE*:** Use the PDC log, GROUPA/B, which contains extended group information that the GRPA/B log does not.

Syntax 2:

These commands are used to create and configure groups. Groups that are added are automatically saved to non-volatile memory. If ten groups already exist, an error message is returned.

GROUP ADD groupname *[arguments & data]*

Command	Option	Description	Default
GROUP ADD	-	Command	
groupname	group name	The name of a group (e.g. “alpha”) which is either being created or modified	
arguments & data	logname,trigger, period, destination override	Add or change a log directive within a group by means of these fields, which are interpreted exactly as stated in the *MiLLennium GPSCard Command Descriptions Manual* except for destination override which may be a specified file as well as COM1 or COM2, see the Destination Override section following this table. Commas must be used; here, spaces are not acceptable. If the log trigger does not require a rate (such as ONCE or ONCHANGED), then zero (0) must be used as the rate. Offset log times are not supported. A group can support a maximum of ten log directives.	
	ECUTOFF,value	The parameter ECUTOFF (elevation cut-off, in degrees) is entered by specifying the appropriate optional argument and a value. This value is sent to the GPS receiver at the start of the group’s logging session.	
	POS, option	The options are: FIX *lat,lon,hgt [,stnid[,stnhlth]]* for a fixed position or AVE *maxtime,maxhor,maxver* for position averaging See the POS notes following this table.	
	MODE, option	The options are STATIC or KINEMATIC Specifying KINEMATIC disables autogeneration of site records on opening a log file. Specifying STATIC results in site records being autogenerated every time a log file is opened (if it is not already at a site). The current mode can be viewed in the GROUPA/B log and is indicated by the GROUP_ST_KINEMATIC bit in the GroupStatus field.	STATIC
	SATLIMIT,value	You can specify the minimum number of satellites desired while logging any of the following logs: RGEA/B/D, MKPA/B, POSA/B, PRTKA/B, PXYA/B, RTKA/B or SPHA/B, by entering this optional argument and a value. Logging of these logs is suspended if less than the required number of satellites are being used in the position solution. This value is different from the “minsats” field in the header log (HDRA), which describes the minimum number of satellites used in the positions solution for any of these logs actually recorded in a log file.	
	ASN,value	Enter the antenna serial number by specifying this optional argument and a value of up to 16 alphanumeric characters. It is stored for information purposes only and is not used further.	
	ATYPE,value	Enter the antenna type by specifying this optional argument and a value of up to 16 alphanumeric characters. It is stored for information purposes only and is not used further.	
	AHEIGHT,value	Enter the nominal antenna height (in meters) by specifying this optional argument and a value. It is stored for information purposes only and is not used further.	

Note: The GROUP command lists the group table information as a series of GRPA logs, which do not include the extended group information. Extended group information can be viewed by issuing a PDC LOG GROUPA command.

Examples:

```
group add alpha
group add alpha com1,p20a,ontime,5
group add alpha ecutoff,3
group add alpha satlimit,6
group add alpha asn,25674337
group add alpha atype,502NK
group add alpha aheight,1.67
```

DESTINATION OVERRIDE

GROUP ADD groupname *logname,trigger,period,[com1][,com2][,file]*

The following destination override information should be noted for the above command syntax:

- If the destination override (COM1, COM2 or FILE) is not specified by the scheduler or by using the LOGGROUP command, the *logname* specified is sent to the default destination. The default destination override is a log file destination for a scheduled or POWERUP session and a user-specified destination for a LOGGROUP session.
- If only the FILE destination override is specified, then the log specification will only be used if the default destination is also FILE. In other words, a manual logging session with a COM-port destination will ignore all log specifications for which the destination override is specified only as FILE.
- If the destination override is specified as either COM1 or COM2, the log specification will only be used if no other session for which the default destination is COM1 or COM2, respectively, is in progress at the instant the group is executed. This is only relevant if more than one LOGGROUP sessions are in progress at the same time.
- Previous logging to the default destination is stopped before the beginning of a logging session. Previous logging to any useable destination, subject to the above restrictions, as specified in the optional destination override in the particular group, is stopped. In other words, any previous logging on the channel is only stopped if the group is actually going to use the channel.
- At the end of the logging session, logging is only stopped on the session default destination. In other words, log specifications with a port override that differs from the default port are not unlogged at the end of the logging session.

POS NOTES

GROUP ADD groupname pos fix *lat,lon,hgt[,stnid[,stnhlth]]*

GROUP ADD groupname pos ave *maxtime,maxhor,maxver*

- Either FIX or AVE configurations can be specified in the group but not both.
- Specifying the POS option without any other following arguments cancels any previous POS requests.
- The AVE configuration must have all the options *maxtime*, *maxhor*, and *maxver* specified where hor and ver denote horizontal and vertical. If you do not wish to enter *maxver* or *maxver* and *maxhor*, then 0 (zero) should be entered in these fields instead. It is not possible to enter a non-zero *maxver* parameter without entering a valid *maxhor* parameter.
- GPS receiver requests are cancelled for position averaging and fixing position on the completion of a logging session that includes the POS configuration. In case of multiple simultaneous manual logging sessions that include the POS configuration, the parameters from the session that is the last to start is in effect for all the sessions. This configuration persists until the last session that includes the POS configuration is stopped.

Syntax 3:

This function deletes group information from the non-volatile memory. It is possible to remove an entire log group, or only an individual log from a group.

GROUP DEL groupname [log name]

Command	Option	Description
GROUP DEL	-	Command
groupname	group name	The name of a group (e.g. “alpha”) which is either being deleted or modified
log name	log name	An individual log, currently an element of the named group, which is to be removed from this group

Examples:

```
group del alpha
group del alpha p20a
```

Syntax 4:

This command is used to delete all group information from the non-volatile memory.

```
GROUP CLEAR
```

Syntax 5:

This command is used to copy group information from group *groupname_from* to group *groupname_to*. If *groupname_to* already exists, *groupname_from* overwrites it.

GROUP COPY *groupname_from* *groupname_to*

LOGGROUP

This command provides a means of manually specifying immediate logging commands; this command disables scheduled operation. Logging can be directed to a specific file, or to a specific serial port. The filename is rejected if it conflicts with an existing filename. One of the serial ports may be specified in lieu of a filename, in which case the logs are transmitted from the specified port. If no filename or serial port is specified, a file is opened with an auto-generated filename and data is logged to it. If a serial port is designated as the destination, no SoftSurv header or HDRA log is issued; rather, a GRPA log is issued to give the logging parameters.

If a filename is specified, the extension .PDC is automatically added. A path cannot be specified; that is, the file is created in the default working directory.

There are two syntactical forms, as shown below:

Syntax 1:

The system allows you to select multiple log groups to be active simultaneously, but not to the same port. For example, “loggroup test testfile” and “loggroup default com1” will result in the “test” group being logged to a file named TESTFILE.PDC, and the “default” group being logged through the COM1 serial port. However, the commands “loggroup test com1” and “loggroup default com1” will result in the first loggroup session being cancelled and the second started.

LOGGROUP groupname [keyword]

Command	Option	Description
LOGGROUP	-	Command
groupname	group name	The name of a group (e.g. “alpha”) which is to be logged.
keyword	filename	The name of the file (without the .PDC ending) in which data will be recorded.
	COM1 or COM2	The serial port to which data will be sent.

Examples:

```
loggroup alpha
loggroup alpha test
loggroup alpha com2
```

Syntax 2:

This form of the command terminates manual logging, allowing scheduled logging to resume. If no argument is given, all logging is disabled, and scheduled operation resumes. Note that to disable logging to a file, you would enter "loggroup disable file" without mentioning a specific file name. Similarly, to disable logging to a serial port, you would enter "loggroup disable com1" or "loggroup disable com2".

If multiple log groups are active, and subsequently some are disabled individually, scheduled operation resumes when no active log groups remain.

To stop scheduled logging, use the "schedule abort" command that disables logging for the remainder of a scheduled event. The next schedule event will then start normally.

`LOGGROUP DISABLE` *[keyword]*

Command	Option	Description
LOGGROUP	-	Command
keyword	FILE	Enter this word to disable logging to a file. Do not enter a specific file name.
	COM1 or COM2	Enter one of these words to disable logging to a serial port.

Examples:

```
loggroup disable
loggroup disable file
loggroup disable com1
```

METS

This command is used to control the display and logging of meteorological conditions. Upon receipt of a METS command, a META log is inserted into the current log file.

If the command is issued without any of the optional fields, the 10 most recent meteorological records are displayed (most recent first) as a sequence of META logs. If there are fewer than 10 records, a MSGA log containing a CMDFAIL message follows the META logs.

You can also use this command to specify the ambient meteorological conditions. Enter up to 3 of the optional fields in any order, provided that the syntax is observed.

Syntax:

`METS` `[temp=degrees]` `[press=hPa]` `[humid=percent]`

Command	Option	Description	Default
METS	-	Command	
temp=	temperature	Specify ambient temperature, in degrees centigrade	
press=	pressure	Specify ambient barometric pressure, in hectopascals (1 hPa = 1 mbar)	
humid=	humidity	Specify ambient relative humidity, as a percentage	

Examples:

```
mets
mets press=996.5
mets humid=89 temp=28 press=996.5
```

PDC

The PDC LOG, PDC UNLOG and PDC UNLOGALL commands are used to control logging of PDC parameters to either a COM port or to a data file. The behavior of PDC LOG, PDC UNLOG and PDC UNLOGALL commands are consistent with the behavior of the Millennium GPSCard LOG, UNLOG and UNLOGALL commands, respectively, with the following notes:

- The PDC LOG command is restricted to a maximum log rate of 1Hz, and supports only the ONCE, ONTIME and CONTINUOUSLY triggers. A trigger specification of CONTINUOUSLY is equivalent to a trigger specification of ONTIME, 1.
- Only selected PDC logs are supported by the pdc command (see datatype in *Syntax 1*). PDC log structure is described on *Page 64.*

The PDC FRESET command (*Syntax 4*) restores the factory configuration of the PDC parameters.

Syntax 1:

`PDC LOG` *`[destination]`* `datatype` *`[trigger]`* *`[period]`* *`[offset]`* *`{hold}`*

Syntax	Description	Example
PDC LOG		PDC LOG
destination	COM1 or COM2 or FILE	COM1
datatype	Enter one of the valid ASCII or Binary PDC logs, see *Page 64*.	STATUSA
trigger	ONTIME [period] [offset], ONCE or CONTINUOUSLY	ONTIME
period	Used with the ONTIME trigger (seconds).	60
offset	Used with the ONTIME trigger (seconds). It provides the ability to offset the logging events. If you wished to log data at 1 second after every minute you would set the period to 60 seconds and the offset to 1 second (the default is 0).	1
hold	Will prevent a log form being removed when the PDC UNLOGALL command is issued.	

Syntax 2:

This command permits you to remove a specific log request from the system.

If [destination] is not specified, it is defaulted to the port that the command was received on. This feature eliminates the need for you to know which port you are communicating on if you want logs to come back to the same destination you sent commands to.

`PDC UNLOG` *`[destination]`* `datatype`

Syntax	Range Value	Description
UNLOG	-	Command
destination	COM1, COM2, FILE	COMn port or log file from which PDC log originated
datatype	Any valid PDC log	The name of the log to be disabled

Example:

```
pdc unlog com1 statusa
```

Syntax 3:

If [destination] is specified (COM1, COM2 or FILE) this command disables all logs on the specified destination only. All other ports are unaffected. If [destination] is not specified, this command disables all logs on all ports.

`PDC UNLOGALL [destination]`

Example:

```
pdc unlogall
```

Syntax 4:

This command restores the factory configuration of the PDC parameters and causes the receiver to enter power-down mode.

```
PDC FRESET
```

PROJECT

The PROJECT command defines project-related parameters and causes the insertion of a PROJECTB log, see *Page 78*, into the header of the log file prior to the start of the logging session. The PROJECT command without any arguments causes the output of a PROJECTA log. A project defined using the PROJECT command spans multiple logging sessions, until the receipt of a PROJECT CLEAR command.

Syntax 1:

Displays the current project as a PROJECTA log.

```
PROJECT [option]
```

Command	Option	Description
PROJECT	-	Command
option	(none)	Entered without arguments, this command displays the current project as a PROJECTA log.

Examples:

```
project
```

Syntax 2:

Cancels the current project. This command does not delete project data from a file that is already open or from previously logged files.

```
PROJECT CLEAR
```

Command	Option	Description
PROJECT CLEAR	-	Command

Example:

```
project clear
```

Syntax 3:

Defines the current project parameters.

```
PROJECT ADD [project] [agency] [observer]
```

Command	Option	Description
PROJECT ADD	-	Command
project		Project description
agency		Agency description
observer		Observer description

Example:

```
Project add demo_city company Mr_Smith
```

PSN

This command displays serial number information by issuing a PSNA log.

Syntax:

```
PSN
```

PVERSION

This command displays PDC serial, version and model numbers by issuing a PDCVERA log.

Syntax:

```
PVERSION
```

RENAME

This command changes the name of a file on a PC Card. Wildcards are not permitted. The file's name cannot incorporate a file path. The name of an open log file cannot be changed. Refer to *File Name Convention, Page 29*, for information on naming files.

Syntax:

```
RENAME old name new name
```

Command	Option	Description	Example
RENAME	-	Command	
old name		Specify the existing name of the file, including the extension	test.pdc
new name		Specify the new name of the file, including the extension	i98feb20.pdc

Example:

```
rename test.pdc i98feb20.pdc
```

SCHEDULE

This command allows you to display the current logging schedule, alter the schedule, delete the schedule, and turn scheduled data logging on or off. All day and time specifications are given and interpreted in universal time coordinates (UTC). Only one schedule can be active at any time. Schedule entries assign a one-character code to each of seven days, as shown in the following table:

Table 16: Weekday Abbreviations

Weekday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Abbreviation	d	m	t	w	r	f	s

The scheduler operates perpetually; i.e. if an event is scheduled to occur on a Monday, this event is serviced every Monday that the system is in operation. See *Schedule Logging Operation, Page 29*, for more information on this topic. If no day-of-week specifier is given, the event occurs every day.

No file extensions are needed when specifying a file. For user-specified filenames, the first character must be non-numeric to avoid conflicts with auto-generated names, which always have a number as the first character. See also *File Name Convention, Page 29*, for more information on this topic.

There are multiple syntactical forms, as shown following.

Syntax 1:

SCHEDULE [*keyword*]

Command	Option	Description
SCHEDULE	-	Command
keyword	ABORT	Terminate a scheduled logging operation prior to its normal completion. The DL then resumes normal operation at the completion of the aborted event. For manual logging, see the LOGGROUP command, *Page 53*. This command stores the current data file; thus, all data is saved up to the time when the command is issued.
	CLEAR	Delete the entire schedule table from non-volatile memory. Not reversible.
	DISABLE	Temporarily suspend scheduled operation. If scheduled logging is taking place when this command is issued, the logging operation is suspended until system control is returned to the DL by means of the SCHEDULE ENABLE command, or by restarting the DL.
	ENABLE	Restore system and logging control to the DL. This command causes the DL to start logging as required by the stored schedule events.

Examples:

```
schedule
schedule abort
schedule clear
schedule disable
schedule enable
```

Invoked without optional arguments, this command displays the current logging schedule. The output format is a set of SCHA logs, followed by MSGA log with Code=3001, Error=CMDFAIL, SubCode=1002, SubCodeMsg=ENDSCDLIST

Example:

```
Com1> schedule
SCHA,1,rt_logs,1700,1800*xx[CR][LF]
SCHA,2,diff_set,mwrf1200,1215*xx[CR][LF]
SCHA,3,my_data,1400,1530*xx[CR][LF]
MSGA,3001,CMDFAIL,1002,ENDSCDLIST,,19971105,1325,*66[CR][LF]
```

Syntax 2:

This form of the command allows you to delete a specific schedule entry from non-volatile memory. The entry number identifier must be specified. To find the entry number, issue a “schedule” command to get a listing of all entries and their respective entry numbers. Once this entry is removed, the remaining schedule entries are renumbered.

SCHEDULE DEL [entry]

Command	Option	Description	Default
SCHEDULE DEL	-	Command	
entry		Specify the schedule entry number that you wish removed. This is not reversible.	

Example:

```
schedule del 4
```

Syntax 3:

This form of the command is used to create additional table entries in the non-volatile memory. The group identifier must be a valid log group. The time specification gives the day and time of the week that logging is to take place on; the days are abbreviated as indicated in *Table 16: Weekday Abbreviations, Page 57*.

The start and end times are specified in 24-hour notation. If the end time is less than the start time, the logging wraps over to the next day. All day and time specifications are given and interpreted in universal time coordinates (UTC). Up to 7 days can be specified.

SCHEDULE ADD `groupname` `scheduling` `[filename]`

Command	Option	Description	Default
SCHEDULE ADD	-	Command	
groupname	group name	The name of a group (e.g. “alpha”) which is being modified	
scheduling	ddddddhhmm,dhhmm	The start and stop time between which logging is to occur. For the start time, enter the day of week (up to seven specifiers can be selected), then the hour of the day (2-digit number), followed by the minute of the hour (2-digit number). After the comma, enter the stop time in the same way, except that only one day specifier is allowed, for the case where recording starts on one day and ends on a subsequent day. If no day-of-week specifier is given, the event occurs every day.	
filename	filename	The name of the file (without the .PDC extension) in which data will be recorded. You can only provide a file name when you are scheduling a single data collection event; if you are scheduling a series of events, you have to accept the DL’s auto-generated names. If you specify a single recurring event with a named file (e.g. log data on Mondays between 1600 and 1700, and place the data in file TEST.PDC), the first Monday this would occur. If you did nothing, the following Monday a file-name conflict would occur; in that case, the DL creates a file name whose first character is a tilde (“~”), followed by a 7-digit random number, and a .PDC extension (e.g. ~9368412.PDC).	

Examples:

```
schedule add alpha 1600,1700 i98feb20
```

- An entry is added to the “alpha” group, causing logging to occur every day between the times 1600 to 1700. The data is directed to the I98FEB20.PDC file, although the data could have also been directed to a file with an auto-generated name.

```
schedule add alpha m1600,1700 i98feb20
```

- An entry is added to the “alpha” group, causing logging to occur on Mondays between the times 1600 to 1700. The data is directed to the I98FEB20.PDC file, although the data could have also been directed to a file with an auto-generated name.

```
schedule add alpha m1600,w1700
```

- An entry is added to the “alpha” group, causing logging to occur between 1600 on Mondays and 1700 on Wednesdays. The data is directed to a file with an auto-generated name, although a named file is allowable in this case.

```
schedule add alpha mwf1600,1700
```

- An entry is added to the “alpha” group, causing logging to occur on Mondays, Wednesdays, and Fridays, between the times 1600 to 1700. The data is directed to files with auto-generated names; a named file is not allowable in this case

SITE

This command is used to control the display and logging of site logs, and to control site information. It causes data fields to be recorded in the SITELOGA message.

Use of the LEAVE option causes the site data to be recorded in the form of a SITELOGB log.

- The FIRSTGPSWEEK and FIRSTGPSSEC fields of the SITELOGB log correspond to the time of the first position log (RGEA/B, MKPA/B, POSA/B, POSA/B, PRTKA/B, PSYA/B, RTKA/B or SPHA/B) received, with the number of Space Vehicles (SV) used in the position solution greater than zero, between the SITE ADD and SITE LEAVE commands. The accuracy of the field is 5 seconds.
- The LASTGPSWEEK and LASTGPSSEC fields of the SITELOGB log correspond to the time of the last position log received, with the number of SVs used in the position solution greater than zero, between the SITE ADD and SITE LEAVE commands. The accuracy of the field is 5 seconds.
- If no position logs are received, with the number of SVs used in the position solution greater than zero, between the SITE ADD and SITE LEAVE commands:
  - the FIRSTGPSWEEK, FIRSTGPSSEC, LASTGPSWEEK and LASTGPSSEC fields of the SITELOGB log are set to correspond to the times at which the SITE ADD and SITE LEAVE commands were issued, respectively,
  - the SITE_ST_INVALID bit (0x01) will be set in the flags field of the SITELOGB log
  - if a manual SITE LEAVE is being performed (rather than an automatic one), a MSGA log with Code = 3001, Error = CMDFAIL, SubCode = 65 and SubCodeMsg = "site record marked invalid" are issued to the COM port where the SITE LEAVE originated.
- If no position logs are received with the number of SVs used in the position solution greater than zero, within 30 ($\pm$5) seconds after a SITE ADD, but received before a SITE LEAVE command:
  - the SITE_ST_STARTTRUNCATE bit (0x02) is set in the Flags field of the SITELOGB log
  - if a manual SITE LEAVE is being performed (rather than an automatic one), a MSGA log with Code = 3001, Error = CMDFAIL, SubCode = 62 and SubCodeMsg = "site start time truncated" are issued to the COM port where the SITE LEAVE originated.
- If no position logs are received with the number of SVs used in the position solution greater than zero, within 30 ($\pm$5) seconds before a SITE LEAVE but received at some time after a SITE ADD command:
  - the SITE_ST_ENDTRUNCATE bit (0x04) is set in the Flags field of the SITELOGB log
  - if a manual SITE LEAVE is being performed (rather than an automatic one), a MSGA log with Code = 3001, Error = CMDFAIL, SubCode = 63 and SubCodeMsg = "site leave time truncated" are issued to the COM port where the SITE LEAVE originated.
- If both of the above conditions apply, (i.e. if no position logs are received with the number of SVs used in the position solution greater than zero, within 30 ($\pm$5) seconds after a SITE ADD but received before a SITE LEAVE command and if no position logs are received with the number of SVs used in the position solution greater than zero, within 30 ($\pm$5) seconds before a SITE LEAVE but received at some time after a SITE ADD command):
  - both, the SITE_ST_STARTTRUNCATE and SITE_ST_ENDTRUNCATE bits are set in the Flags field of the SITELOGB log
  - if a manual site leave is being performed (rather than an automatic one), a MSGA log with Code = 3001, Error = CMDFAIL, SubCode = 64 and SubCodeMsg = "site start and leave times truncated" are issued to the COM port where the site leave originated

If no SITE LEAVE or SITE CANCEL command is issued prior to a the completion of a logging session (schedule, POWERUP or manual), a SITE LEAVE command is performed automatically once the logging session is complete.

There are multiple syntactical forms, as shown below:

Syntax 1:

SITE [*keyword*]

Command	Option	Description
SITE	-	Command
keyword	(none)	This command causes the 10 most recent site records to be displayed (most recent first) as a sequence of SITELOGA messages. If there are fewer than 10 logs, a MSGA log containing a CMDFAIL message will follow the SITELOGA logs. There is no limit on the number of SITELOGA logs entered into a single log file.
	LEAVE	This command causes the current time to be entered in the site record as the departure time, and the site data to be written to the log file. Attempting to perform a SITE ADD when a SITE LEAVE command for a previously added site has not been issued, is an error.
	CANCEL	This serves to undo the SITE ADD command for the current site, deleting it. This operation is not reversible.

Examples:

```
site
site leave
site cancel
```

Syntax 2:

This command creates a new site in the system, with a time stamp corresponding to the current time. This command is used to announce arrival at a site. DL assigns an identification code to each site; up to 999 sites can be defined, with the first one being numbered 1. Specific site information can be entered or updated using the SITE UPDATE command. Attempting to perform a SITE ADD when a SITE LEAVE command for a previously-added site has not been issued, is an error.

If no SITE ADD command is issued prior to a logging session (scheduled, POWERUP or manual), a SITE ADD command is performed automatically at the beginning of the logging session with the parameters “name” and “attribute” set to the log filename and 0, respectively.

SITE ADD name attribute [*aheight[ameasure]*]

Command	Option	Description	Default
SITE ADD	-	Command	
name		Enter a descriptive name (up to 32 alphanumeric characters, no spaces) to define the site where data collection occurs.	
attribute		Enter an integer code (an integer up to 4 digits long, of your choosing) that describes this type of site.	
aheight		(Optional) Enter the antenna’s height, in meters.	
ameasure		(Optional) Enter a code (up to 16 alphanumeric characters, no spaces) that describes how the antenna’s height was determined.	

Examples:

```
site add hilltop 4
site add SW_corner_of_fence 143 1.402 tape_measure
```

Syntax 3:

Specific site information can be entered or updated using this command. You can enter 1 to 4 of the optional fields in any order, provided that the syntax is observed. If no value is specified after the '=' sign of a field, its value is cleared, that is, a default value is assigned to it.

```
SITE UPDATE [number=site number] [name=site name]
            [ameasure=mcode] [attrib=attribute]
```

Command	Option	Description	Default
SITE UPDATE	-	Command	
number=		Enter a site number (up to 8 alphanumeric characters, no spaces) to identify a set of collected data.	
name=		Enter a descriptive name (up to 32 alphanumeric characters, no spaces) to define the site where data collection occurs.	
aheight=		Enter the antenna's height, in meters.	
ameasure=		Enter a code (up to 16 alphanumeric characters, no spaces) that describes how the antenna's height was determined.	
attrib=		Enter an integer code (an integer up to 4 digits long, of your choosing) that describes this type of site.	

Examples:

```
site update name=bridge
site update aheight=1.52 name=NE_corner_of_pier attrib=2
site update ameasure=502-TRUE number=7ABCD8 aheight=1.203 name=statue
```

SLEEP

This command allows you to enable or disable the power-saving mode. SLEEP, entered with no arguments, causes the DL to disable manual logging (if active), then enter low-power mode and wait for scheduled events. If a logging event is scheduled to start within a short amount of time, the DL will not enter low-power mode.

Syntax:

```
SLEEP [keyword]
```

Command	Option	Description
SLEEP	-	Command
keyword	OFF	Disable the low-power mode and cause the DL to stay fully powered between scheduled events.

Examples:

```
sleep
sleep off
```

STATUS

This command displays current system status information by issuing a LPSTATUS log.

Syntax:

```
STATUS
```

VOUT

This command turns On or Off the battery (BAT) peripheral power output on the COM2 port. BAT is always turned On whenever a battery is first connected to the receiver, and it is also turned On whenever the receiver is turned off with the power button. See the section on *Peripheral Power Supply, Page 21*.

Syntax:

VOUT *periph* *option*

Command	Option	Description
VOUT	-	Command
	periph	BAT
	option	On or Off

Examples:

```
vout BAT on
vout BAT off
```

WRITE

This command causes the data to be written to a specified filename on the PC Card. The maximum length of data is 200 characters.

If hex is not specified then only printable ASCII characters can be used, except for a $ sign which cannot be used.

If hex is specified, the data is treated as a string of pairs of hexadecimal characters, with each pair representing a byte to be written to the file (the pairs must be linked together in the data string, giving a maximum of 100 hex characters.

A new file is created if the specified filename does not exist. If the specified filename already exists, data is appended to the end of the file. Only simple filenames with a maximum of 8 characters and an optional 3-character extension are supported.

Syntax:

WRITE *[hex]* *filename* *“data”*

Examples:

```
write myfile.dat “Hello World”
write hex myfile.dat “3B2F9DB3”
```

APPENDIX F - DL LOGS

The DL firmware generates the following logs in addition to those of the MiLLennium GPSCard log set:

Log	Description
BATA/B	Battery system information
DIRA/B	Summary of stored logs in memory
GROUPA/B	An extension of the GRPA/B log for a log file
GRPA/B	DL logging configuration for a file
HDRA/B	DL system set-up information
LPSTATUSA/B	DL system status information
METAB/B	Meteorological information
MSGA/B	Error messages
PDCVERA/B	Display PDC serial, version and model numbers
PROJECTA/B	Project related parameters
PSNA/B	System serial numbers
SCHA/B	Schedule entry information
SITELOGA/B	Information about an observation site
STATUSA/B	An extension of the LPSTATUS log

For a complete listing and description of the other logs that the DL is capable of generating, please consult the *MiLLennium GPSCard Command Descriptions Manual*. It also contains procedures and explanations related to data logging.

Before proceeding to describe these logs, mention should be made of the DL data file format (*.PDC).

PDC FILES

In a PDC file, the sequence of data exists in the following format:

SoftSurv Header
HDRB
GRPB (or GROUPB if extended group features used
PROJECTB (if defined)
GPS Logs
SITELOGB #1
GPS Logs
:
GPS Logs
SITELOGB #n
GPS Logs
EOF

Site records meteorological logs (MET) may occur at arbitrary locations throughout the file. The records are linked to allow easy extraction. The SoftSurv Header information block consists of 128 bytes:

Item	Type	Size	Description	Range	Offset
Description	char	60	File Description. ^Z can be included to indicate that the description is less than 60 characters.		0
EOF	byte	1	C:\ TYPE will not pass this point (artificial end of file)	^Z	60
Signature	char	7	“NOVATEL”		61
FileCode	byte	1	Indicates the type of file.		68
Version	byte	1	Version number	0+	69
Revision	byte	1	Revision number	0 to 99	70
Reserved	byte	57	Reserved for future use		71

The HDRB and GRPB logs are binary versions of the HDRA and GRPA logs described in the following sections.

BATA/B

The BATA/B log is used to display information about the battery system.

BATA

Structure:

Field #	Field type	Data Description	Example
1	$BATA	Log header	$BATA
2	Source	Which battery is selected	A
3	BattA	Battery A voltage (in mV)	10950
4	BattB	Battery B voltage (in mV)	11685
6	*xx	Checksum	*55
7	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$BATA,A,10950,11685*55[CR][LF]
```

BATB

Message ID = 1032; Message byte count = 24

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Source	1	Char		12
3	Filler	3	Char		13
4	BattA	4	Integer	milliVolts	16
5	BattB	4	Integer	milliVolts	20

DIRA/B

The DIRA/B log is used to present a summary of stored logs in the DL memory module.

DIRA

Structure:

Field #	Field type	Data Description	Example
1	$DIRA	Log header	$DIRA
2	FileName	Name of stored log file (8.3 format)	31240201.PDC
3	FileSize	Size of stored log file in bytes	412514
4	Date	Date file was last updated (*yyyymmdd*)	19971022
5	*xx	Checksum	*43
6	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$DIRA,31240201.PDC,412514,19971022*43[CR][LF]
```

DIRB

Message ID = 1027; Message byte count = 36

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	FileName	13	Char		12
3	Filler	3	Char		25
4	FileSize	4	Unsigned long	Bytes	28
5	Date	4	Unsigned long		32

GROUPA/B

The GROUPA/B log captures the GPSCard logging configuration used to generate a particular log file, containing Group Status and Log Status information, important site information, and differential corrections base station parameters.

GROUPA

Structure:

Field #	Field type	Data Description	Example
1	$GROUPA	Log header	$GROUPA
2	GroupName	Log group	DIFFBASE
3	SessionName	Session Name	8ABC9
4	AntSN	Antenna serial number	CGA95040020
5	AntType	Antenna type	502NK
6	AHeight	Antenna height (m)	2.050000
7	ECutoff	Elevation cutoff (degrees)	5.000000
8	SatLimit	Satellite observations limit	5
9	GroupStatus	Group status flag (hexadecimal), see *Table .*	01
10	StnHealth	Station health	4
11	StnID	Station ID	1
12	Lat_Time	Latitude (degrees) or Time (s)	51.116321
13	Long_Horz	Longitude (degrees) or Horizontal (m)	-114.038336
14	Height_Vert	Height (m) or Vertical (m)	1048.207
15	SiteNumber	Site number	7ABCD8
16	SiteName	Site name	Company Building
17	Ameasure	Antenna height measurement method	502-TRUE
18	Res1	Reserved for future use	
19	Res2	Reserved for future use	
20	Res3	Reserved for future use	
21	LogID	Log identifier	P20A
22	LogTrigger	Trigger event for log	ONTIME
23	LogRate	Repetition period for log	10.00
24	LogStatus	Log status flag (hexidecimal), see *Table 18: Log Status Word Encoding, Page 68*.	01
25	Res4	Reserved for future use	
26 …n-2	…	Additional log specifications	…
n-1	*xx	Checksum	*23
n	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$GROUPA,DIFFBASE,8ABC9,CGA95040020,502NK,2.050000,5.000000,5,01,4,1,
51.116321,-114.038336,1048.207,7ABCD8,Company Building,502-TRUE,,,,
P20A,ONTIME,10.00,01,,RGEA,ONTIME,2,01,,REPA,ONCHANGED,0,02,*23[CR][LF]
```

Table 17: Group Status Word Encoding

Field	Bit Mask	Description
GROUP_ST_FIX	0x01	GPS Position fixed, 1 = fixed, 0 = unfixed
GROUP_ST_AVE	0x02	GPS Position averaged, 1 = averaged, 0 = not averaged
GROUP_ST_KINEMATIC	0x04	Survey type, 1 = kinematic, 0 = static

Table 18: Log Status Word Encoding

Field	Bit Mask	Description
LOG_ST_COM1	0x01	Log is being logged to COM port 1.
LOG_ST_COM2	0x02	Log is being logged to COM port 2.
LOG_ST_FILE	0x04	Log is being logged to log file on PDC card.

GROUPB

Message ID = 1037; Message byte count = 180+X*36

Format:

Field #	Data	Bytes	Format	Units	Offset
1	Sync	3	Char		0
(header)	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer	Bytes	8
2	GroupName	10	Char		12
3	SessionName	9	Char		22
4	AntSN	17	Char		31
5	AntType	17	Char		48
6	Filler	3	Char		65
7	AHeight	4	Float	Meters (m)	68
8	ECutoff	4	Float	Degrees	72
9	SatLimit	4	Integer		76
10	GroupStatus	1	Unsigned char		80
11	StnHealth	1	Unsigned char		81
12	StnID	2	Unsigned short		82
13	Lat_Time	8	Double	Degrees or (s)	84
14	Long_Horz	8	Double	Degrees or (m)	92
15	Height_Vert	8	Double	(m) or (m)	100
16	SiteNumber	9	Char		108
17	SiteName	33	Char		117
18	Ameasure	17	Char		150
19	Res1	1	Char		167
20	Res2	4	Integer		168
21	Res3	8	Double		172
22	Log Specification	X*36	Structure		
	LogID	9	Char		180,180+X*36…
	LogTrigger	17	Char		189,189+X*36…
	Filler	2	Char		206,206+X*36…
	LogRate	4	Float	Seconds	208,208+X*36…
	LogStatus	1	Unsigned char		212,212+X*36…
	Res4	3	Char		213,213+X*36…

GRPA/B

The GRPA log captures the GPSCard logging configuration used to generate a particular file.

The group name may have up to and including nine characters. If the log trigger does not require a rate, (such as 'ONCE' or 'ONCHANGED'), then zero (0) must be specified as the rate.

GRPA

Structure:

Field #	Field type	Data Description	Example
1	$GRPA	Log header	$GRPA
2	GroupName	Log group	DIFFBASE
3	SessionName	Session Name	8ABC9
4	AntSN	Antenna serial number	CGA95040020
5	AntType	Antenna type	502NK
6	AHeight	Antenna height (in metres)	2.050000
7	ECutoff	Elevation cutoff (degrees)	5.000000
8	SatLimit	Satellite observations limit	5
9	LogID	Log identifier	P20A
10	LogTrigger	Trigger event for log	ONTIME
11	LogRate	Repetition period for log	10.00
12 …n-2	…	Additional log specifications	…
n-1	*xx	Checksum	*23
n	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$GRPA,DIFFBASE,8ABC9,CGA95040020,502NK,2.050000,5.000000,5,P20A,ONTIME,
10.00,RGEA,ONTIME,2,REPA,ONCHANGED,0,*23[CR][LF]
```

GRPB

Message ID = 1026; Message byte count = 80+X*32

Format:

Field #	Data	Bytes	Format	Units	Offset
1	Sync	3	Char		0
(header)	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	GroupName	10	Char		12
3	SessionName	9	Char		22
4	AntSN	17	Char		31
5	AntType	17	Char		48
6	Filler	3	Char		65
7	AHeight	4	Float	Meters	68
8	ECutoff	4	Float	Degrees	72
9	SatLimit	4	Integer		76
10	LogSpec	X*32	Structure		
	LogID	9	Char		80,80+X*32…
	LogTrigger	17	Char		89,89+X*32…
	Filler	2	Char		106,106+X*32…
	LogRate	4	Float	Seconds	108,108+X*32…

HDRA/B

The HDRA/B log is used to capture system set-up information in a log file.

HDRA

Structure:

Field #	Field type	Data Description	Example
1	$HDRA	Log header	$HDRA
2	FileName	Name of stored log file (8.3 format)	31240201.PDC
3	FileSize	Size of stored log file in bytes	412514
4	Date	Date file was last updated (*yyyymmdd*)	19971022
5	DL SN	DL serial number	CNN98160050
6	GPSSN	Receiver serial number	CGN97120038
7	GPSModel	Receiver firmware model	MILLENSTD
8	GPSVersion	Receiver firmware/boot version	4.437/2.03
9	PDCSN	PDC serial number	CNM97510010
10	PDCModel	PDC firmware model	DLSTD
11	PDCVersion	PDC firmware/boot version	1.053/1.01
12	MinSats	Minimum satellites in log	6
13	Start GPSWeek	GPS Week of first log	912
14	Start GPSSec	GPS Time of first log (s)	602500.000000
15	End GPSWeek	GPS Week of last log	913
16	End GPSSec	GPS Time of last log (s)	102345.000000
17	SiteLogP	File offset to last Site Record	200312
18	MetLogP	File offset to last Met Record	184300
19	UTCOffset	UTC offset	-12
20	Res1	Reserved for future use	
21	Res2	Reserved for future use	
22	Res3	Reserved for future use	
23	Res4	Reserved for future use	
24	Res5	Reserved for future use	
25	*xx	Checksum	*22
26	[CR][LF]	Sentence terminator	[CR][LF]

Affected only by RGEA/B/D, MKPA/B, POSA/B, PRTKA/B, PXYA/B, RTKA/B, SPHA/B logs.

Example:

```
$HDRA,31240201.PDC,412514,19971022,CNN98160050,CGN97120038,MILLENSTD,
4.437/2.03,CNM97510010,DLSTD,1.053/1.01,6,912,602500.000000,913,
102345.000000,200312,184300,-12,,,,,*22[CR][LF]
```

HDRB

Message ID = 1025; Message byte count = 228

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	FileName	13	Char		12
3	Filler	3	Char	Bytes	25
4	File size	4	Unsigned long	Bytes	28
5	Date	4	Unsigned long	yyyymmdd	32
6	DLSN	16	Char		36
7	GPSSN	16	Char		52
8	GPSModel	20	Char		68
9	GPSVersion	20	Char		88
10	PDCSN	16	Char		108
11	PDCModel	20	Char		124
12	PDCVersion	20	Char		144
13	MinSats	4	Unsigned long		164
14	StartGPSWeek	4	Unsigned long	GPS Week	168
15	StartGPSSec	8	Double	GPS Seconds	172
16	EndGPSWeek	4	Unsigned long	GPS Week	180
17	Filler	4	Char		184
18	EndGPSSec	8	Double	GPS Seconds	188
19	SiteLogP	4	Unsigned long	Bytes	196
20	MetLogP	4	Unsigned long	Bytes	200
21	UTCOffset	4	Integer	Seconds	204
22	Res1	4	Unsigned long	Bytes	208
23	Res2	4	Unsigned long		212
24	Res3	4	Unsigned long		216
25	Res4	4	Unsigned long		220
26	Res5	4	Unsigned long		224

Affected only by RGEA/B/D, MKPA/B, POSA/B, PRTKA/B, PXYA/B, RTKA/B, SPHA/B logs.

LPSTATUSA/B

The LPSTATUS log is used to display system status information. The PDC State and GPSCard Status are represented as hexadecimal digits, which are described in *Table 21: PDC Status Word Encoding* and *Table 22: GPS Status Word Encoding (see the STATUSA/B log, Page 83).* The GROUP command does not support this log. LPSTATUSA/B is now obsolete in that it is still supported for backward compatibility but will disappear in the next major revision of software due to having been superseded by a superior log (STATUSA/B).

LPSTATUSA

Structure:

Field #	Field type	Data Description	Example
1	$LPSTATUSA	Log header	$LPSTATUS
2	Source	Battery used	A
3	BattA	Battery A voltage (milliVolts)	11750
4	BattB	Battery B voltage (milliVolts)	10890
5	CardIn	PC Card indicator (1=inserted)	1
6	CardFree	Unused bytes remaining on PC Card	1992403
7	PDC Status	Current PDC status (*see Table 21: PDC Status Word Encoding, Page 84*)	3AF
8	GPS Status	GPSCard status (*see Table 22: GPS Status Word Encoding, Page 85*)	1
9	FileName	Name of current log file	01929383.PDC
10	*xx	Checksum	*55
11	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$LPSTATUS,A,11750,10890,1,1992403,3AF,1,01929383.PDC*55[CR][LF]
```

LPSTATUSB

Message ID = 1029; Message byte count = 56

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Source	1	Char		12
3	Filler	3	Char		13
4	BattA	4	Integer	milliVolts	16
5	BattB	4	Integer	milliVolts	20
6	CardIn	4	Boolean		24
7	CardFree	4	Unsigned long	Bytes	28
8	PDCStatus	4	Unsigned long		32
9	GPSStatus	4	Unsigned long		36
10	FileName	13	Char		40
11	Filler	3	Char		53

META/B

The META/B log is used to display meteorological information.

META

Structure:

Field #	Field type	Data Description	Example
1	$META	Log header	$META
2	GPSWeek	GPS week	512
3	GPSSec	GPS seconds	220400.000000
4	Flag	Valid fields (binary 000 – 111)	7
5	Temp	Temperature (degrees Celsius)	23.000000
6	Press	Pressure (hPa)	1013.250000
7	Humid	Relative humidity (%)	55.200000
8	MetLogP	Pointer to Previous Mets Log	1536
9	*xx	Checksum	*55
10	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$META,512,220400.000000,7,23.000000,1013.250000,55.200000,1536*55,[CR][LF]
```

METB

Message ID = 1031; Message byte count = 52

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	GPSWeek	4	Unsigned Long	Week	12
3	Filler	4	Char		16
4	GPSSec	8	Double	Seconds	20
5	Flag	4	Unsigned Long		28
6	Temp	4	Float	Celsius	32
7	Press	4	Float	hPa	36
8	Humid	4	Float	Percent	40
9	MetLogP	4	Unsigned Long	Bytes	44
10	Filler	4	Char		48

MSGA/B

This log displays messages in response to system events or user commands.

MSGA

Structure:

Field #	Field type	Data Description	Example
1	$MSGA	Log header	$MSGA
2	code	Error code (*see Table 19: MSGA Error Code Definition, Page 76*)	3001
3	error	Error description (*see Table 19: MSGA Error Code Definition, Page 76*)	CMDFAIL
4	subCode	Error sub code	0041
5	subCodeMsg	Error sub code message	SYNTAX ERROR
6	subCodeArg	Error sub code argument	DIR [FILENAME]
7	date	Date of error event (*yyyymmdd*)	19971105
8	time	Time of error event, UTC (*hhmm*)	1325
9	*xx	Checksum	*66
10	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$MSGA,3001,CMDFAIL,0041,SYNTAX ERROR,DIR [FILENAME],19971105,1325,
*66[CR][LF]
```

The error codes that appear in Fields 2 & 3 above are described in *Table 19: MSGA Error Code Definition, Page 76*. They are generated in response to system events:

Table 19: MSGA Error Code Definition

Code	Error	System event
2001	BISTFAIL	Built-in Self Test failed
2002	PWRFAIL	Power Failed
2003	BATTLOWA	Low Voltage from battery A (< 10.7V)
2004	BATTLOWB	Low Voltage from battery B (< 10.7V)
2005	SWBATT	Battery switch performed
2006	TEMPWARN	High temperature warning
2007	TEMPFAIL	High temperature shutdown
2008	DISKLOW	Low storage space remaining (< 10% of card capacity)
2009	DISKFULL	No storage space remaining
2010	DISKGONE	PC Card removed
3001	CMDFAIL	User-command feedback
3003	DISKERR	An error occurred while trying to access the PC Card
3007	BOOTOK	System boot successful
3008	PWRLOW	Entering low-power mode
3010	LOGNAME	Specified filename already exists
3025	DISKIN	PC Card detected and configured
3026	DISKCAPOK	Storage space OK (> 10% of card capacity)

MSGB

Message ID = 1024, Message byte count = 96

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Code	4	Integer		12
3	Error	10	Char		16
4	Filler	2	Char		26
5	SubCode	4	Integer		28
6	SubCodeMsg	32	Char		32
7	SubCodeArg	24	Char		64
8	Date	4	Unsigned long		88
9	Time	4	Unsigned long		92

PDCVERA/B

This log is used to display PDC serial, version and model numbers.

PDCVERA

Structure:

Field #	Field type	Data Description	Example
1	$PDCVERA	Log header	$PDCVERA
2	PDCVersion	PDC Version Number	0.28
3	PDCDateTime	PDC S/W Compile Date/Time	May 3 1998 12:16:52
4	PDCModel	PDC Model	PDCSTD
5	PDCSN	PDC Serial Number	CNM7053000
6	*xx	Checksum	*4A
7	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$PDCVERA,0.28,May 3 1998 12:16:52,PDCSTD,CNM7053000*4A[CR][LF]
```

PDCVERB

Message ID = 1034; Message byte count = 89

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	PDCVersion	20	Char		12
3	PDCDateTime	21	Char		32
4	PDCModel	20	Char		53
5	PDCSN	16	Char		73

PROJECTA/B

The PROJECT command, see *Page 56*, defines project-related parameters and causes the insertion of a PROJECTB log into the header of the log file prior to the start of the logging session. The PROJECT command without any arguments causes the output of a PROJECTA log. A project defined using the PROJECT command may span multiple logging sessions.

PROJECTA

Structure:

Field #	Field type	Data Description	Example
1	$PROJECTA	Log header	$PROJECTA
2	Project	Project description	Demo_city
3	Agency	Agency description	Company
4	Observer	Observer description	Mr_Smith
5	*xx	Checksum	*55
6	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$PROJECTA,Demo_city,Company,Mr_Smith*55[CR][LF]
```

PROJECTB

Message ID = 1036; Message byte count = 111

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Project	33	Char		12
3	Agency	33	Char		45
4	Observer	33	Char		78

PSNA/B

The PSNA/B log is used to display system serial numbers.

PSNA

Structure:

Field #	Field type	Data Description	Example
1	$PSNA	Log header	$PSNA
2	PDCSN	PDC Serial number	SNM98070012
3	GPSSN	GPSCard Serial number	SGL98050098
4	DLSN	DL System Serial number	CNN98080044
5	*xx	Checksum	*55
6	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$PSNA,SNM98070012,SGL98050098,CNN98080044*55[CR][LF]
```

PSNB

Message ID = 1033; Message byte count = 60

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	PDCSN	16	Char		12
3	GPSSN	16	Char		28
4	DLSN	16	Char		44

SCHA/B

The SCHA/B log is used to display entry information for scheduled logging. Refer to *File Name Convention*, *Page 29*, for information on file names. See also *Table 16: Weekday Abbreviations*, *Page* 57, for a description of weekday abbreviations.

SCHA

Structure:

Field #	Field type	Data Description	Example
1	$SCHA	Log header	$SCHA
2	Index	Schedule index	2
3	GroupName	Log group name	diff_set
4	StartTime	Time of week to start logging, UTC (*ddddddhhmm*)	mwrf1200
5	EndTime	Time of week to stop logging, UTC (*ddddddhhmm*)	1215
6	FileName	Name of log file in which to store data	01225402.PDC
7	*xx	Checksum	*55
8	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$SCHA,2,diff_set,mwrf1200,1215,01225402.PDC*55[CR][LF]
```

SCHB

Message ID = 1028; Message byte count = 64

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Index	4	Integer		12
3	GroupName	10	Char		16
4	StartTime	12	Char		26
5	EndTime	12	Char		38
6	FileName	13	Char		50
7	Filler	1	Char		63

SITELOGA/B

The SITELOGA/B log is used to display information about an observation site.

SITELOGA

Structure:

Field #	Field type	Data Description	Example
1	$SITELOGA	Log header	$SITELOGA
2	SiteNumber	Site Number (8 char)	7ABCD8
3	SiteName	Site Name (32 char)	NovAtel Building
4	Attrib	Attribute code (User defined)	2
5	AHeight	Antenna height	2.000000
6	AMeasure	Ant height measure method (user defined, 16 char)	502-TRUE
7	FirstGPSWeek	Date of arrival	892
8	FirstGPSSec	Time of arrival	500405.000000
9	LastGPSWeek	Date of departure	893
10	LastGPSSec	Time of departure	250450.000000
11	Flags	Data logging flags, *see Table 20: Flag Word Encoding, Page 81*	1
12	SiteLogP	File offset from previous SITELOGB log	1536
13	*xx	Checksum	*55
14	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$SITELOGA,7ABCD8,NovAtel Building,2,2.000000,502-TRUE,892,500405.000000,
893,250450.000000,1,1536,*55[CR][LF]
```

Table 20: Flag Word Encoding

Field	Bit Mask	Description
SITE_ST_INVALID	0x01	0 = Valid, 1 = Invalid
SITE_ST_STARTTRUNCATE	0x02	0 = Did truncate start time, 1 = Did not truncate start time
SITE_ST_ENDTRUNCATE	0x04	0 = Did truncate end time, 1 = Did not truncate end time

SITELOGB

Message ID = 1030; Message byte count = 124

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	SiteNumber	9	Char		12
3	SiteName	33	Char		21
4	Filler	2	Char		54
5	Attrib	4	Integer		56
6	AHeight	4	Float	Meters	60
7	AMeasure	17	Char		64
8	Filler	3	Char		81
9	FirstGPSWeek	4	Unsigned Long	GPS Week	84
10	Filler	4	Char		88
11	FirstGPSSec	8	Double	GPS Seconds	92
12	LastGPSWeek	4	Unsigned Long	GPS Week	100
13	Filler	4	Char		104
14	LastGPSSec	8	Double	GPS Seconds	108
15	Flags	4	Integer		116
16	SiteLogP	4	Unsigned Long		120

STATUSA/B

The STATUS log is used to display system status information and is an extension of the LPSTATUSA/B log. The PDC State and GPSCard Status are represented as hexadecimal digits, which are described in *Table 21: PDC Status Word Encoding* and *Table 22: GPS Status Word Encoding, Page 85*.

STATUSA

Structure:

Field #	Field type	Data Description	Example
1	$STATUSA	Log header	$STATUSA
2	Source	Battery used	A
3	BattA	Battery A voltage (milliVolts)	11750
4	BattB	Battery B voltage (milliVolts)	10890
5	CardIn	PC Card indicator (1=inserted)	1
6	CardFree	Unused bytes remaining on PC Card	1992403
7	PDC Status	Current PDC status (*see Table 21: PDC Status Word Encoding, Page 84*)	3AF
8	GPS Status	GPSCard status (*see Table 22: GPS Status Word Encoding, Page 85*)	1
9	FileName	Name of current log file	01225402.PDC
10	Temperature	Internal temperature (°C)	60
11	Date	Current date (yyyymmdd)	19981229
12	Time	Current time (hhmmss)	093525
13	Reserved 1	Reserved for future use	
14	Reserved 2	Reserved for future use	
15	Reserved 3	Reserved for future use	
16	Reserved 4	Reserved for future use	
17	*xx	Checksum	*55
18	[CR][LF]	Sentence terminator	[CR][LF]

Example:

```
$STATUS,A,11750,10890,1,1992403,3AF,1,01225402.PDC,60,19981229,093525,,,,*55
[CR][LF]
```

Table 21: PDC Status Word Encoding

Field	Bit Mask	Description
PDC_ST_HW	0x001	Hardware status, 1 = OK
PDC_ST_LINK	0x002	GPSCard link established, 1 = OK
PDC_ST_BATT	0x004	Battery status, 1 = OK, 0 = warn/fail
PDC_ST_TEMP	0x008	Temp status, 1 = OK, 0 = warn/fail
PDC_ST_SLEEP	0x010	Sleep mode, 1 = enabled
PDC_ST_LOGGING	0x020	Logging, 1 = active
PDC_ST_ONSITE	0x040	Site state, 1 = onsite (“site add” command received but not “site leave”)
PDC_ST_TIMESET	0x080	Time established, 1 = OK
PDC_ST_CARDIN	0x100	PC Card presence, 1 = PC Card inserted
PDC_ST_SCHEDON	0x200	Scheduled data collection status, 1 = enabled
PDC_ST_NVMVALID	0x400	NVM valid, 1=OK
PDC_ST_COMBATON	0x800	BAT peripheral power output enabled
PDC_ST_COM5VON	0x1000	5V peripheral power output enabled
PDC_ST_CARDOK	0x2000	No disk-access errors, 1 = no errors

STATUSB

Message ID = 1035; Message byte count = 84

Format:

Field #	Data	Bytes	Format	Units	Offset
1 (header)	Sync	3	Char		0
	Checksum	1	Char		3
	Message ID	4	Integer		4
	Message byte count	4	Integer		8
2	Source	1	Char		12
3	Filler	3	Char		13
4	BattA	4	Integer	milliVolts	16
5	BattB	4	Integer	milliVolts	20
6	CardIn	4	Boolean		24
7	CardFree	4	Unsigned long	Bytes	28
8	PDCStatus	4	Unsigned long		32
9	GPSStatus	4	Unsigned long		36
10	FileName	13	Char		40
11	Filler	3	Char		53
12	Temperature	4	Integer	Celsius	56
13	Date (yyyymmdd)	4	Unsigned long		60
14	Time (hhmmss)	4	Unsigned long		64
15	Res1	4	Integer		68
16	Res2	4	Integer		72
17	Res3	4	Unsigned long		76
18	Res4	4	Unsigned long		80

Table 22: GPS Status Word Encoding

Field	Bit Mask	Description
GPS_ST_ACTIVE	0x1	GPSCard active, 1 = active
GPS_ST_POSITION	0x2	GPS Position status, 1 = OK
GPS_ST_FIXED	0x4	GPS Position fixed, 1 = fixed, 0 = unfixed

APPENDIX G - CONVERSIONS

Listed below are several commonly used equivalents between the SI (Système Internationale) units of weights and measures used in the metric system, and those used in other systems.

Distance

1 metro (m) = 100 centimeters (cm) = 1000 millimeters (mm)
1 kilometer (km) = 1000 metros (m)
1 international foot = 0.3048 metro
1 US survey foot = 0.3048006096 metro
1 statute mile = 1609.3 metros
1 nautical mile = 1852 metros

Temperature

degrees Celsius = (5/9) x [(degrees Fahrenheit) - 32]
degrees Fahrenheit = [(9/5) x (degrees Celsius)] + 32

Volume

1 liter (l) = 1000 cubic centimeters (cc)
1 gallon (Imperial) = 4.546 litters
1 gallon (US) = 3.785 litters

Weight

1 kilogram (kg) = 1000 grams
1 pound = 0.4536 kilogram (kg)

Decimal, Hexadecimal & Binary Equivalents

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

GPS Time of Week (e.g. 511 306 seconds) to Calendar Day

1. (511 306 seconds) / (86 400 seconds / day) = **5**.917893519 **days**
2. (0.917893519 days) x (24 hours / day) = **22**.02944444 **hours**
3. (0.02944444 hours) x (60 minutes / hour) = **1**.76666667 **minutes**
4. (0.76666667 minutes) x (60 seconds / minute) = **46 seconds**
5. **So, 511 306 seconds = Day 5 (Thursday) + 22 hours, 1 minute, 46 seconds into Friday.**

Calendar Date

E.g. 11:30 hours, January 22, 1995 (before GPS week rollover August 22, 1999)
Days from January 6, 1980 to January 22, 1995 = 15 years x 365 days / year = 5475 days
Add a day for each leap year (a year that is divisible by 4 but not by 100; every 100 years a leap year is skipped) = 4 days
Days into 1995 (22nd is not finished) = 21 days
Total days = 5500 days
Deduct 5 days: January 1st through to January 5th, 1980 = 5495
GPS Week: 5495 x 86400 seconds per day = 474768000 seconds/604800 seconds per week = **785**
Seconds into week: 22nd day: 11.5 hrs x 3600 seconds/hr = **41400**
GPS time of week: **Week 785, 41400 seconds**

E.g. 13:30 hours, January 28, 2005 (after GPS week rollover August 22, 1999)
Days from August 22, 1999 to January 28, 2005 = 6 years x 365 days / year = 2190 days
Add a day for each leap year = 2 days
Days into 2005 (28th is not finished) = 27 days
Total days = 2219 days
Deduct 21 days: August 1st through to August 21st, 1999 = 2198
GPS Week: 2198 x 86400 seconds per day = 189907200 seconds/604800 seconds per week = **314**
Seconds into week: 28th day: 13.5 hrs x 3600 seconds/hr = **48600**
GPS time of week: **Week 314, 48600 seconds**

APPENDIX H - REPLACEMENT PARTS

The following is a list of the replacement parts available for the DL. Should you require assistance or need to order additional components, please contact your dealer or NovAtel Customer Service representative.

Part Description	NovAtel Part Number
I/O strobes cable (*Figure 13: I/O Cable - Illustration*)	01016330
Straight serial data cable (*Figure 11: Straight Serial Cable - Illustration*)	01016383
Optional 25-pin straight serial data cable	01016384
Null-modem serial data cable (*Figure 12: Null-Modem Serial Cable - Illustration*)	01016329
Power cable assembly: LEMO 4-pin plug to cigarette-lighter plug (*Figure 10: Power Cables*)	01016622
Optional power cable : LEMO 4-pin plug to LEMO 4-pin plug (*Figure 10: Power Cables*) Camel pack size: 33.5 cm DL base case size: 75.0 cm	 01016665 01016666
Optional power assembly: autoranging AC/DC converter/battery charger to LEMO 4-pin socket and AC power cord (*Figure 10: Power Cables*)	GPS-ACDL
Optional Y-cable (*Figure 10: Power Cables*)	01016690
Optional battery assembly (*Figure 10: Power Cables*)	01016698
4 MB Sandisk PC Card	20023715
SoftSurv User Manual	OM-20000023
MiLLennium GPSCard Command Description Manual	OM-20000041
Optional mounting bracket	70015024

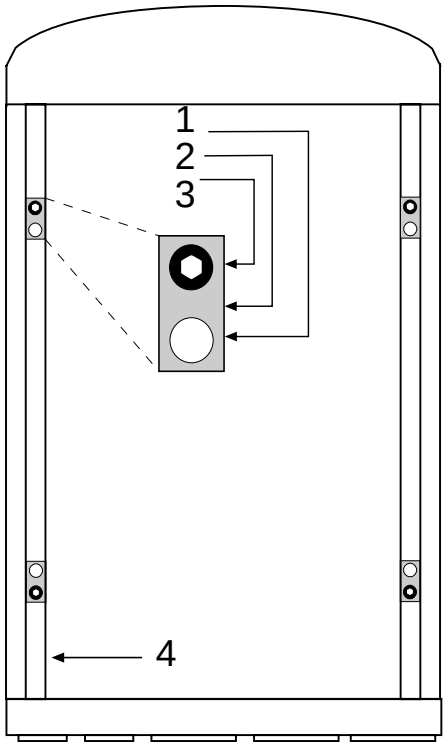
The following original manufacturers' part numbers are provided for information only; they are not available from NovAtel as separate parts.

Part Description	LEMO Part Number
4-pin plug connectors on power cable (*Figure 10: Power Cables*)	FGM.0B.304.CLLD52Z
8-pin plug connector on I/O cable (*Figure 13: I/O Cable - Illustration*)	FGJ.1K.308.CLLC45Z
10-pin plug connector on both serial data cables (*Figure 11: Straight Serial Cable - Illustration & Figure 12: Null-Modem Serial Cable - Illustration*)	FGG.1K.310.CLAC55Z

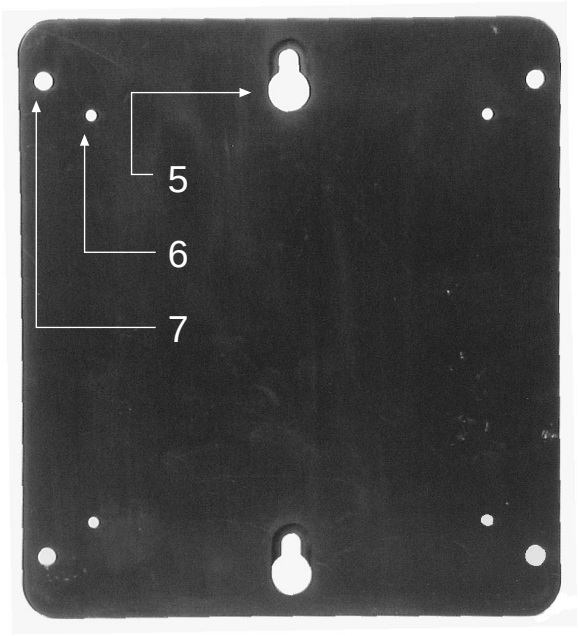
APPENDIX I - OPTIONAL MOUNTING BRACKET

This appendix includes drawings, photographs, and installation instructions for the optional mounting bracket. This bracket can be used to attach the DL to a surface or tripod.

Figure 14: Mounting Bracket



8



9

Reference	Description
1	Thread for flat screw
2	Rectangular nut
3	Grub screw
4	Channel
5	Quick mounting holes to mount assembly to surface using wood screws
6	Holes to mount plate to enclosure using flat screw
7	Holes to mount assembly to a surface using self-tapping screws
8	Bottom of DL enclosure
9	Front of mounting plate

The mounting kit includes the following materials:

- four self-tapping screws (#10-16 x ½″ LG)
- two wood screws (#10 x ¾″ LG)
- four flat screws (M3 x 8, 90° countersink)
- aluminum mounting plate (see *Figure 15* for exact dimensions)

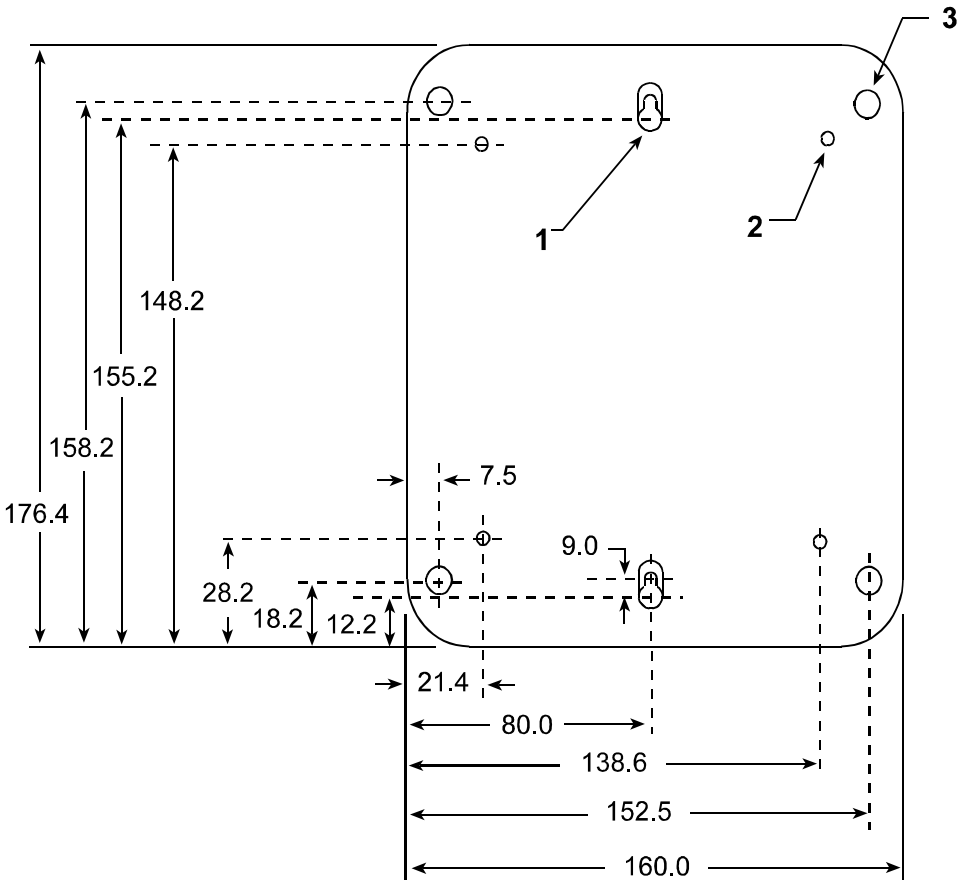
First, the mounting plate needs to be attached to the DL enclosure. There are two channels running the length of the bottom of the DL enclosure. In each of these channels there are two rectangular nuts, held in place by grub screws.

These four nuts are factory-positioned so that the mounting plate can be attached to the DL enclosure using the four flat screws. Please ensure that the four flat screws are mounted from the countersunk side of the mounting plate.

Once the plate has been attached to the DL enclosure, the entire assembly can then be mounted onto a surface using either the four self-tapping screws through the screw-mount holes, or the two wood screws through the quick-mount holes.

WARNING: The mounting kit is not designed for use in high-dynamics or high-vibration environments. Contact your dealer or NovAtel Customer Service if your application requires the DL to be mounted in these types of environments.

Figure 15: Mounting Bracket Drill Holes – Dimensions



Reference	Description
1	Radius 6.0, 2 places
2	4 x 3.1 diameter, 6.0 x 90 degrees countersink, far side
3	4 x 5 diameter through

NOTE: All dimensions in *Figure 15* are in millimeters.

APPENDIX J - COMMAND PROMPT INTERFACE

Although the recommended way of configuring the DL is through the *UTILITIES* module of SoftSurv, it is possible to communicate directly with the DL via its command prompt, using a PC that is typically connected to COM1 on the DL. You can access the command prompt from a DOS or Windows-based terminal emulation program, or you can send batch files directly to a serial port on the DL.

When the DL turns on, no activity information is transmitted from the serial ports except for the port prompt. A terminal connected to the DL would display one of these two messages on its monitor:

Com1> *if connected to COM1 port,*

or

Com2> *if connected to COM2 port*

You must wait until receiving the MSGA log with a BOOTOK message (*see Appendix F - DL* Logs) before typing any commands.

Commands are typed at the interfacing terminal's keyboard, and sent after pressing the terminal's <↵> or <Enter> key.

TIP: Most valid commands do produce a visible response on the screen; the indication that they have been accepted is a return of the port prompt from the DL. VERSION, HELP and ? are the only commands that do provide a data response other than the port prompt.

Example:

An example of no echo response to an input command is the FIX HEIGHT command. It can be entered as follows:

```
COM2>fix height 550 [Return]
COM2>
```

The above example illustrates command input to the DL COM2 serial port which sets the antenna height as fixed to 550 m above sea level and causes position solutions to be constrained as 2D with height fixed. However, your only confirmation that the command was actually accepted is the return of the **COM2>** prompt.

If a command is incorrectly entered, the DL responds with "Invalid Command Name" (or a more detailed error message) followed by the port prompt.

DOS

One way to initiate multiple commands and logging from the DL is to create DOS command files relating to specific functions. This minimizes the time required to set up duplicate test situations. Any convenient text editor can be used to create command text files.

Example:

For this example, consider a situation where a PC's appropriately configured COM1 serial port is connected to the DL's COM1 serial port, and where a remote terminal is connected to the DL's COM2 serial port. If you wish to monitor the DL's activity, the following command file could be used to do this.

1. Open a text editor on the PC and type in the following command sequences:

```
log com2 sata ontime 15
log com2 etsa ontime 15
log com2 rvsa ontime 60 5
log com2 posa ontime 15
log com2 dopa ontime 15
```

2. Save this with a convenient file name (e.g. C:\GPS\BOOT1.TXT) and exit the text editor.

3. Use the DOS *copy* command to direct the contents of the BOOT1.TXT file to the PC's COM1 serial port:

```
C:\GPS>copy boot1.txt com1
1 files(s) copied
C:\GPS>
```

4. The DL is now initialized with the contents of the BOOT1.TXT command file, and logging is directed from the DL's COM2 serial port to the remote terminal.

WINDOWS

As any text editor or communications program can be used for these purposes, the use of Windows 95 is described only as an illustration. The following example shows how Windows 95 accessory programs *Notepad* and *HyperTerminal* can be used to create a hypothetical waypoint navigation file on a PC, and send it to the DL. It is assumed that the PC's COM1 serial port is connected to the DL's COM1 serial port, and that a remote terminal is connected to the DL's COM2 serial port.

Example:

1. Open *Notepad* and type in the following command text:

```
setnav 51.111 -114.039 51.555 -114.666 0 start stop
magvar -21
log com1 posa ontime 15
log com1 spha ontime 15
log com1 nava ontime 15
log com2 gprmb ontime 15 5
log com2 gpvtg ontime 15 5
log com2 rcca ontime 60
```

2. Save this with a convenient file name (e.g. C:\GPS\BOOTNAV1.TXT) and exit *Notepad*.

3. Ensure that the *HyperTerminal* settings are correctly set up to agree with the DL communications protocol; these settings can be saved (e.g. C:\GPS\OEMSETUP.HT) for use in future sessions. You may wish to use XON / XOFF handshaking to prevent loss of data.

4. Select Transfer | Send Text File to locate the file that is to be sent to the DL. Once you double-click on the file or select Open, *HyperTerminal* sends the file to the DL.

The above example initializes the DL with origin and destination waypoint coordinates and sets the magnetic variation correction to -21 degrees. The POSA, SPHA, and NAVA logs have been set to output from the DL COM1 serial port at intervals of once every 15 seconds, whereas the GPRMB and GPVTG NMEA logs have been set to be logged out of the DL COM2 serial port at intervals of 15 seconds and offset by five seconds. The RCCA log has been set to output every 60 seconds from the DL COM2 serial port.

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