**Maximum Input Current (steady state within 200 ms).** The maximum input current shall be no greater than 30 amps. The maximum power shall be no greater than 800 W.

**Conducted Inrush Current.** The in-rush current surge magnitude above nominal current under normal operations (relays closed before LLDs enabled) shall be less than shown in **Figure 5-13a.**

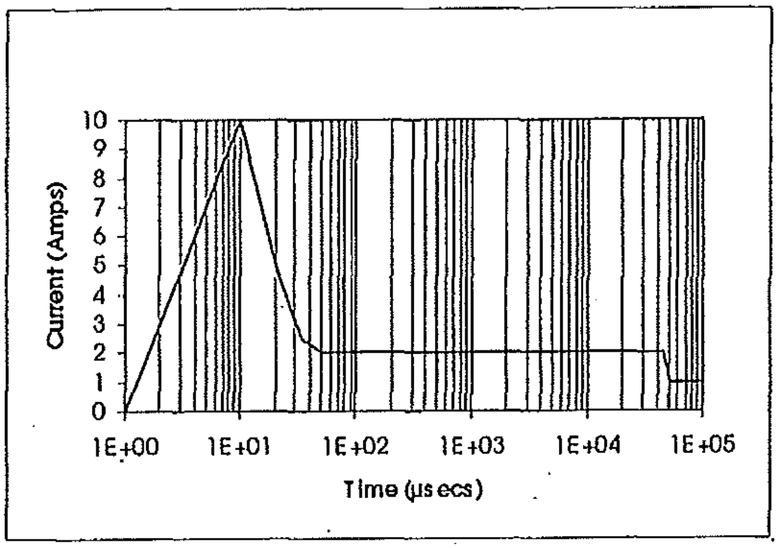


*Figure 5-13a. In-Rush Current Envelope Limit (relative to nominal current)*

### *5.2.4.9 Line Impedance Simulation Network*

A LISN to simulate the actual power-bus impedance into the equipment under shall be used for measurement of the voltage transient levels.

### *5.2.4.10 Raw Input Application and Removal*

The payload shall not be damaged during removal of power due to the power transfer switch.

### *5.2.4.11 (Deleted)*

### *5.2.4.12 Power Control Unit (PCU) Interface*

[redacted] The PCU provides power to the payload via the Payload

Bus (PLB). [redacted]

**PCU Power Source Requirements.** The power output characteristics at the PCU output will comply with the characteristics defined in **Figure 5-15.**

| Characteristic | Heater Supply Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

***Figure 5-15.*** *PCU Power Source Characteristics for Heaters*

**Bus Power Distribution.** [redacted] The PLB shall be a source of switched ~~24-35 Vdc~~ power that is under-voltage and over-current protected. [redacted]

[redacted] Faults include:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

- [redacted]

[redacted]

[redacted]

[redacted]

#### 5.2.4.13 Electrical Grounds, Returns, and References

Ball will provide a bus location for a single point ground for the payload. Grounding, returns, and signal shielding for each type of electrical interface shall be documented in this ICD. Bonding characteristics of interfaces between the payload and the spacecraft are described in Section 5.2.9.1.

### 5.2.5 Solid State Recorder (SSR) Interface

The SSR system is used to store two channels of 32-bit ~~parallel~~ serial data (nonreturn to zero level [NRZ-L] data plus clock and data valid flag) in continuous or block format and reproduce the stored data on two "corresponding" 16-bit parallel digital data channels. Store channel data recorded in SSR channel 1 shall output as reproduce channel 1, and store channel data recorded in SSR channel 2 shall output as reproduce channel 2. The SSR system shall be able to record real-time data, reproducing previously recorded data or record real-time data while reproducing data. The SSR system shall be capable of simultaneous or individual operation of all record or reproduce channels. Recorded and reproduced data shall be processed in a first in/first out mode. The SSR shall have no credible single-point failures.

The SSR system consists of separate redundant solid-state recorders to complete the total system function. The boxes include a power supply, control electronics, and access electronics with common banks of solid-state memory circuits, so no credible single-point failures exist. Each SSR system box provides separate external interfaces as shown in **Figure 5-16.**

### *5.2.5.1 Performance Summary*

The SSR shall perform as follows and as summarized in **Figure 5-17:**

- Record and reproduce data at the rates and formats for the times specified in Figure 5-17.
- Erase previously recorded data only during the record mode
- Provide operational and diagnostic telemetry, including status of the recorder record and reproduce pointers
- Reproduce data several times with addressable data storage resolution of less than 2 Gbit
- Simultaneous record and reproduce
- Provide loop-back operation when in the record mode
- Have a maximum throughput rate of 512/40 Mbps: record rates of 256 Mbps on both channels simultaneous with a reproduce rate of 20 Mbps each channel

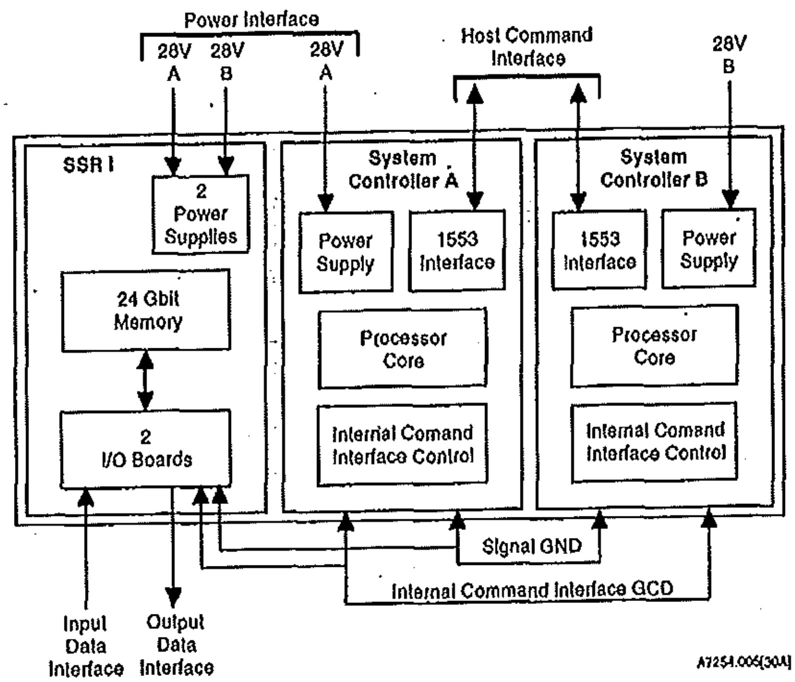


*Figure 5-16. SSR Functional Block Diagram*

| Item | Function | Specification |
|---|---|---|
| 1 | Configuration | Solid state |
| 2 | SSR storage capacity | $25 \times 10^9$ bit each record channel at beginning of life (BOL) |
| 3 | Required record/reproduce | Cycles minimum-3,000,000 |
| 4 | Record/reproduce | Record, Reproduce or simultaneous record/reproduce |
| 5 | Input data channels | 2 |
| 6 | Input data clock rate | Up to 8.5 MHz |
| 7 | Input data lines | Clock, valid flag, and 32 parallel data bits |
| 8 | Output data channels | 2 |
| 9 | Output data clock | 10.5 MHz (from X-band transmitter) Maximum |
| 10 | Output data lines | Turn around clock, valid flag, and 16 parallel data bits |
| 11 | Error rate maximum | 1 in $10^9$ bits minimum end of life |
| 12 | Input data format | NRZ-L |
| 13 | Output data format | NRZ-L |
| 14 | Commands | 1553B |
| 15 | Input voltage | 24 to 35 Vdc |
| 16 | Input power | 100 W max. |
| 17 | Telemetry data | Analog, Thermistor, and 1553B |
| 18 | SSR housekeeping data | 1553B |

*Figure 5-17. SSR Specification Summary*

### 5.2.5.2 Commands

The SSR shall be able to respond to mode control commands for record, reproduce, record stop, reproduce stop, reproduce pointer address, record pointer address, reset, and self test. It shall be possible to command the operations of the two record/reproduce channels separately. The issuance of a command to one record/reproduce channel shall not affect the operations of the other channel.

**Command Interface.** The operating mode and configuration of the SSR shall be selected by 1553B commands. The standard 1553 20-bit command blocks with a remote terminal unit address of 0x19 will specify the prime and redundant SSR controller. There shall be no restraint on command sequencing; that is, the unit may be commanded from any mode directly to any other mode (except diagnostic mode or low power mode to operate mode shall be prefaced by a transition to the SSR standby mode). The SSR shall respond to a valid command within 10 ms.

**Command Mode Descriptions.** As a minimum, each SSR channel shall accept the following commands and operate as described:

- [redacted]
- [redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

### 5.2.5.4 Record Data

[redacted]

[redacted]

*Figure 5-18. Data Record Timing*

The GLAS science and GPS ~~Payload Instrument Controller record~~ data, clock, and data valid signals will interface with the SSR via the Payload Interface Module with serial differential interface circuits as shown in Figure 5-19. The ~~SSR input~~ characteristics of these signals are listed in Figure 5-20. [redacted]

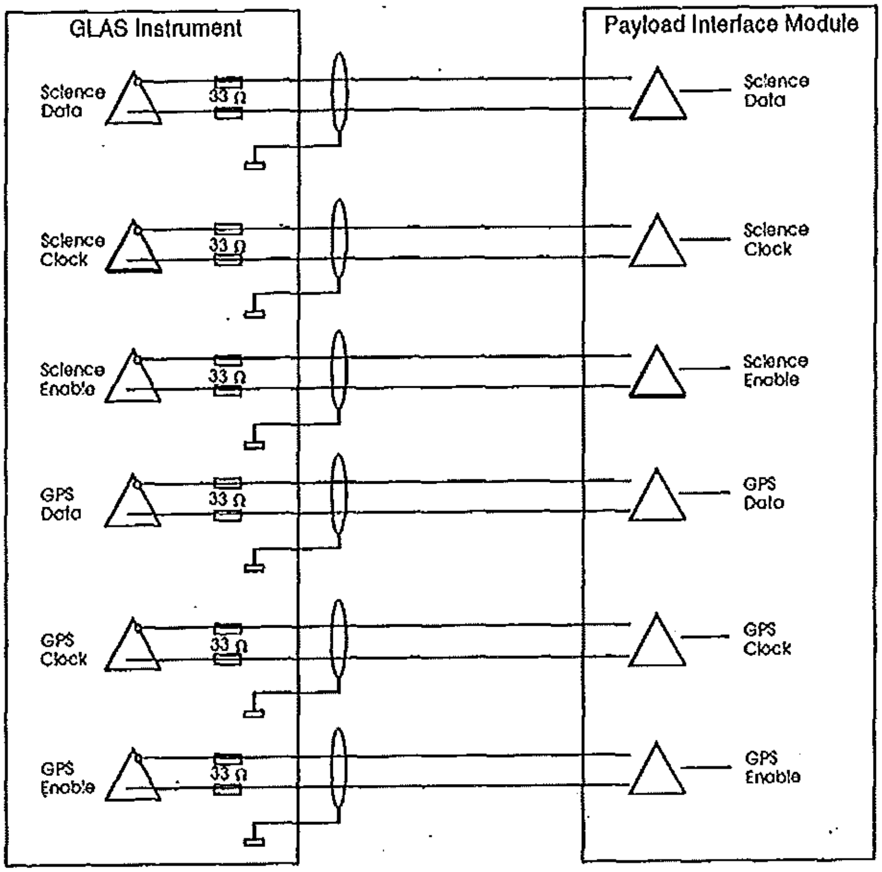


*Figure 5-19. Typical Payload Instrument Controller/SSR Record Data Input Interface*

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-20. ~~SSR~~ Payload Interface Module RS-422 Input Characteristics*

### 5.2.5.6 Bit Error Rate

The error rate at the output data connector over the expected life shall not exceed 1 part in $10^9$ bits.

### 5.2.5.7 Data Capacity

The SSR shall be able to store a minimum of $25x10^9$ bits of data at beginning of life.

### 5.2.5.8 Memory Management

The SSR shall be able upon command to configure the data storage memory, removing from operational status sections of memory that would impede the capability of the system to maintain the required system bit error rate (Section 5.2.5.6). The memory configuration process shall be complete and the unit available for normal operations within 600 s.

### 5.2.5.9 SSR Telemetry Outputs and Test Points

The SSR shall provide digital and analog telemetry for use as status and diagnostic monitors. Digital telemetry outputs shall be accessible over the 1553B bus. A limited number of analog telemetry outputs shall be available as specified in Section 5.2.6 .

### 5.2.5.10 ~~Wideband~~ X-Band Parallel Digital Data Interface

Two redundant RS422 serial digital interfaces are available to output wideband data to the SSR

### 5.2.5.11 ~~Wideband~~ X-Band Data Signal Characteristics

The RS-422 output characteristics of each of the payload wideband data interfaces will be as specified in the following **Figure 5-21.**

| Characteristic | Value | |
|---|---|---|
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| [redacted] | | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |

*Figure 5.21. Payload RS-422 Output Characteristics*

The RS-422 input characteristics at each of the SSR high rate image data interfaces will be as specified in Figure 5-22.

| Characteristic | Value | |
|---|---|---|
| [redacted] | [redacted] | |
| [redacted] | | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |

*Figure 5-22. SSR RS-422 Input Characteristics*

### *5.2.5.12 Data Timing*

Specific payload data timing requirements are specified in this section.

### *5.2.5.13 (Deleted)*

## 5.2.6 Low Rate Telemetry Interface

### *5.2.6.1 Telemetry Signals*

The bus can accommodate payload telemetry output of up to ~~28~~ 8 analog and ~~20~~ 12 thermistor signals.

### *5.2.6.2 Analog Telemetry*

The payload can output to the bus analog telemetry signals for status and downlink. The analog telemetry output characteristics at the payload interface will be in accordance with Figure 5-24.

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-24. Payload Analog Telemetry Output Characteristics*

The analog telemetry input characteristics at the BE interface will be in accordance with Figure 5-25.

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | |
| [redacted] | |
| [redacted] | [redacted] |

*Figure 5-25. BE Analog Telemetry Input Characteristics*

**Analog Telemetry Interface Schematic.** The BE Analog telemetry interface schematic is shown in Figure 5-26. Specific payload telemetry circuit types are shown in detail in Figure 5-27.

[redacted]

[redacted]

### 5.2.6.3 Thermistor Telemetry

A total of up to ~~20~~ 12 thermistor sensors can be supported. The thermistors will be the type 311P18-08T30R, per GSFC S-311-P-18, or the equivalent commercial part. The specific part number and its temperature range is given in Figure 5-28. Each sensor will include 1 foot of twisted pair wire pigtail.

| Part Number | Temperature Range |
|---|---|
| 311P18-08T30R (10 KΩ at 25 °C) or equivalent | -30 °C to +80 °C |

*Figure 5-28. Thermistor Types*

**Thermistor Telemetry Characteristics.** The payload thermistor telemetry input characteristics at the BE interface will be in accordance with **Figure 5-29.**

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-29. Telemetry BE Input Characteristics for Thermistors*

**Thermistor Telemetry Interface Schematic.** The thermistor telemetry interface schematic is shown in **Figure 5-30.**

[redacted]

The measurement *accuracy* of the thermistor telemetry interface is expected to be less than [redacted] for thermistors. The measurement *resolution* of the thermistor telemetry interface is expected to be less than [redacted]

#### 5.2.6.4 GPS Data Handling

ICESat shall provide real-time position estimates to GLAS and to the science SSR at a 1-Hz rate, using an RS-422 interface. A 1-Hz timing pulse shall be provided to GLAS, correlated to the time signals received at 30-second intervals by the TurboRogue GPS receiver.

#### 5.2.6.5 GLAS Data Handling

ICESat shall ingest GLAS star tracker and gyro data over the 1553B bus for use in attitude control. It shall accept health and welfare data for real-time telemetry and storage on the engineering DSU, as described in Section 3.2.5.

### 5.2.7 Command Interface

#### 5.2.7.1 Discrete Command Signals

The ICESat Subsystem provides the following types of discrete command signals to the payload:

- Low-Level Discrete (LLD)
- High-Level Discrete (HLD)~~Pulse (HLP)~~

*LLD Commands.* Ten (TBR) LLD commands are available to the payload.

*LLD Commands Characteristics.* The LLD command input characteristics at the payload interface will be in accordance with **Figure 5-31**.

| Characteristic | Value | |
|---|---|---|
| [redacted] | [redacted] | |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |
| [redacted] | [redacted] | |

*Figure 5-31. Payload LLD Command Input Characteristics*

The LLD command output characteristics at the BE interface will be in accordance with Figure 5-32.

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-32. BE LLD Command Output Characteristics*

*LLD Command Interface Schematic.* The LLD command interface schematic is shown in Figure 5-33.

[redacted]

*HLD Commands.* ~~Twenty-~~Fourteen (TBR) HL~~P~~D commands are available to the payload.

*HLD Command Characteristics.* The HLD command input characteristics at the payload interface will be in accordance with Figure 5-34.

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-34. Payload HL~~P~~D Command Input Characteristics*

The HL~~P~~D command output characteristics at the BE interface will be in accordance with Figure 5.2.7-4.

| Characteristic | Value |
|---|---|
| [redacted] | [redacted] |
| [redacted] | |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

**Figure 5-35.** *BE HLPD Command Output Characteristics*

*HLPD Command Interface Schematic.* The High-Level Pulse Command interface schematic is shown in Figure 5-36.

[redacted]

### 5.2.8 Harnesses

Ball will supply all cabling that interconnects payload components to ICESat bus components. The payload provider will supply all intrapayload cabling.

#### *5.2.8.1 Spacecraft-to-Payload Cabling*

This section shows a simplified cabling interface between the payload electronics and the ICESat bus. All cables shall have an EMI backshell, chassis ground, and signal ground. Cabling constraint will be either tie-downs, staking, or P-clamps between boxes.

To guarantee compatibility in cabling, the vendor shall supply a mating connector for each box I/O that mates with the vehicle. The vendor shall also provide a backshell and strain relief for each mating connector, based on Ball-provided cable information.

#### *5.2.8.2 Intrapayload Cabling*

Identification of intrapayload cabling, including connectors, are specified in this section. The estimated maximum intrapayload cable lengths shall be shown. These cable lengths are based on distances as measured from the geometric center of each exit face.

#### *5.2.8.3 Spacecraft-to-Payload Connectors*

Connector types shall be identified in this section. All cables shall have an EMI backshell, chassis ground, and signal ground.

#### *5.2.8.4 Intrapayload Connectors*

All intrapayload connectors shall be labeled. Cable connector markings can be on the backshell, connector, or on a cable strap ~~(Panduit Part No. PLFIM or equivalent)~~ close to the connector end. The method of cable marking shall conform to the contamination control requirements of this ICD.

#### *5.2.8.5 Flight Plugs*

Dissipative cap plugs shall be present on all connectors when shipped. Any connectors unused when the payload is wired in flight configuration shall have appropriate terminator plugs.

### 5.2.9 EMI/EMC

#### *5.2.9.1 Electrical Bonding*

**Electrical Bonding of Mounting Surfaces.** The mounting surface of payload components will be such that it may be electrically bonded to its spacecraft mounting structure with a resistance less than or equal to 2.5 ~~mW~~ mohm per bond except for composite components. The bolted interface between payload components and the mounting surface shall not preclude electrical bonding to the spacecraft. The bolts or the mounting hardware shall not be the primary electrical bond path.

For composite materials the dc resistance will be ≤ 100 ~~mW~~mohm.

Detail requirements for grounding of all payload units should be provided by the payload provider in this section.

**Electrical Bonding of Electrical Connectors.** The dc resistance between any connector shell and the metallic case in which they are installed shall be < 10 ~~mW~~mohm.

### 5.2.9.2 Separation and Shielding of Circuits

Circuits having incompatible electromagnetic interference characteristics should be segregated in cabling and connectors to the maximum extent possible to minimize interference coupling. If two or more circuit categories must share a connector, pin assignments should be made to provide a maximum of isolation in the connector and facilitate separation of the wiring external to the connector.

Separation and shielding is advised in the following **Figure 5-37.**

| Type of Circuit | Recommended Separation and Shielding |
|---|---|
| [redacted] | [redacted] |
| [redacted] | [redacted] |
| [redacted] | [redacted] |

*Figure 5-37. Circuit Separation/Shielding*

### 5.2.9.3 Emissions and Susceptibility

The payload shall comply with MIL-STD-461, Part 3 for class A2 equipment as defined herein. Test procedures for the payload shall comply with MIL-STD-462.

**Radiated Emissions (RE01, RE02).** The generated ac magnetic fields (RE01) at a distance of 7 cm from any equipment shall not exceed the levels shown in **Figure 5-38.**

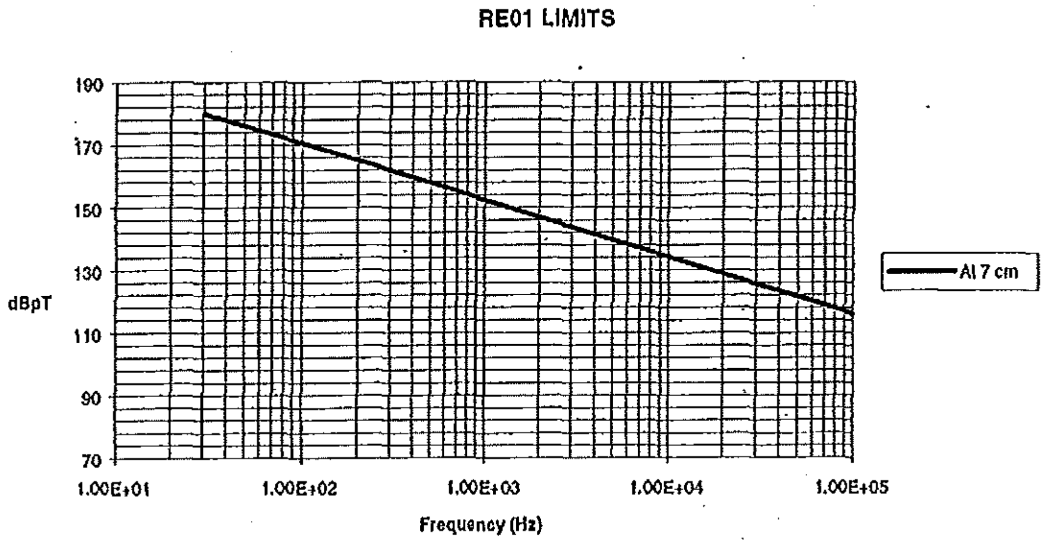


*Figure 5-38. RE01 Magnetic Radiated Emissions Limit*

The design goal for all equipment shall be to demonstrate that the radiated electric field emissions (RE02) are within the requirements of MIL-STD-461 while the absolute limit is specified by **Figure 5-39**, which has been tailored to assure compatibility with ICESat. While testing, the measurement equipment shall be sensitive enough to demonstrate the emissions relative to the MIL-STD-461.

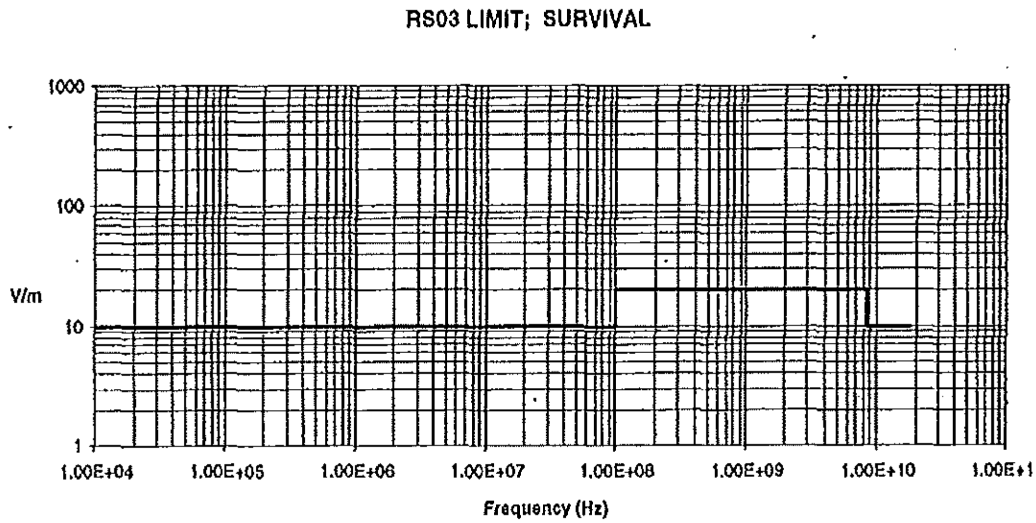


*Figure 5-40. RS03 Radiated Susceptibility Limit (Survival)*

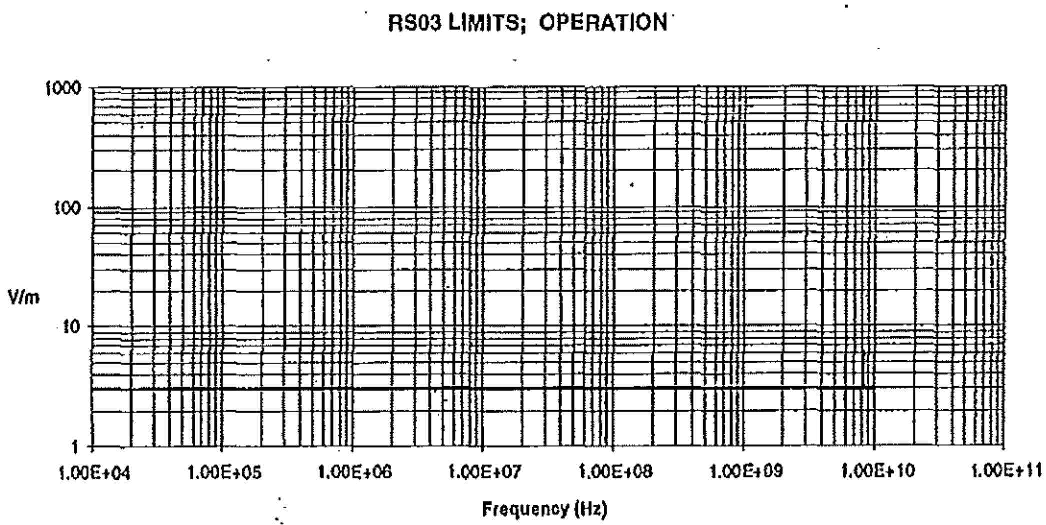


*Figure 5-41. RS03 Radiated Susceptibility Limit (Operate)*

**Conducted Emissions (CE03).** The conducted emission (CE03) levels as measured on the equipment's primary power supply input lines shall remain below the limits shown in **Figure 5-42.** The design goal shall be the MIL-STD-461 limit, while the maximum emissions allowed shall not exceed MIL-STD-461 by more than 10 dB. The requirements for power quality and distortion, and RE02, shall take precedence over this paragraph.

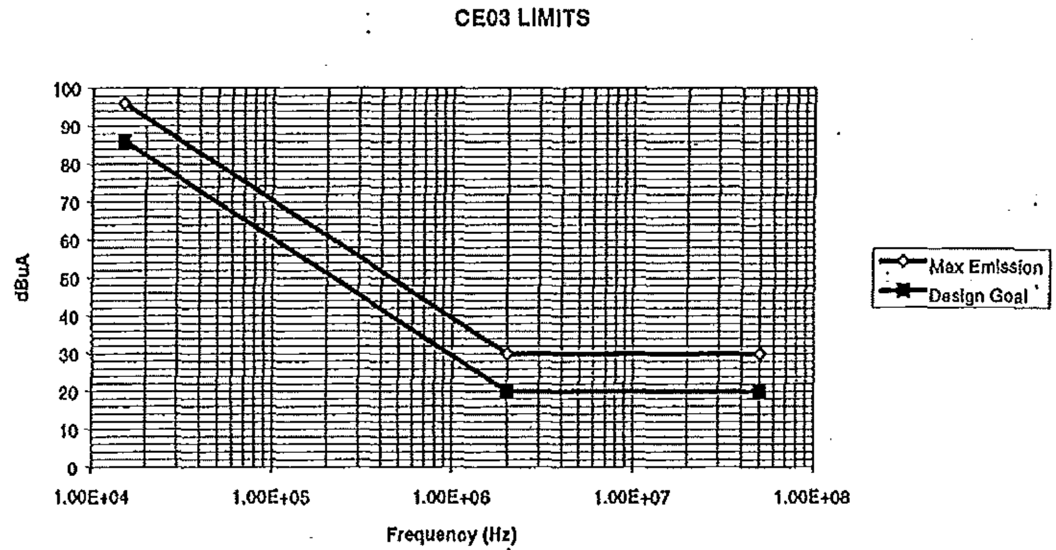


*Figure 5-42. Equipment Conducted Emissions Limit (CE03)*

**Conducted Transient Susceptibility (CS06).** Equipment powered by the spacecraft primary power system shall perform when subjected to a transient voltage spike as defined by MIL-STD 461, Method CS06. The conducted transient wave-form is shown in **Figure 5-43.**

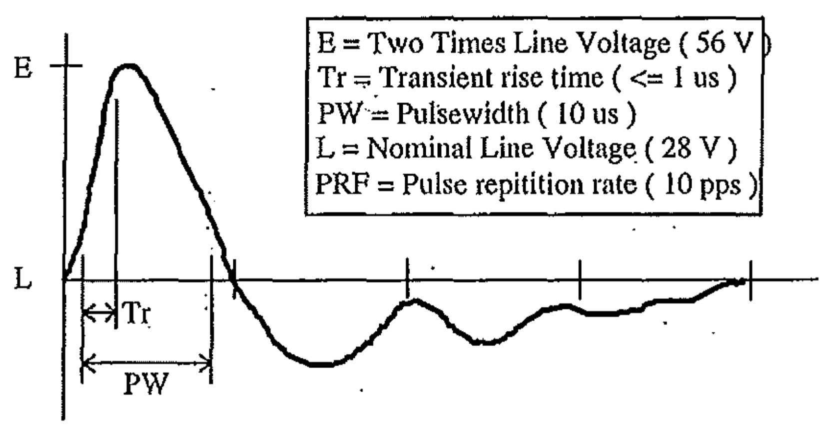


*Figure 5-43. Conducted Transient Wave-Form*

**Conducted Susceptibility (CS01, CS02).** Equipment powered by the spacecraft primary power system shall perform when subjected to a conducted sine wave noise signal injected at the primary power input to the equipment. The conducted susceptibility (CS01/2) signal amplitude shall be injected into the equipment's primary power input lines using the procedures of MIL-STD-462 and the amplitude shown in **Figure 5-44.**

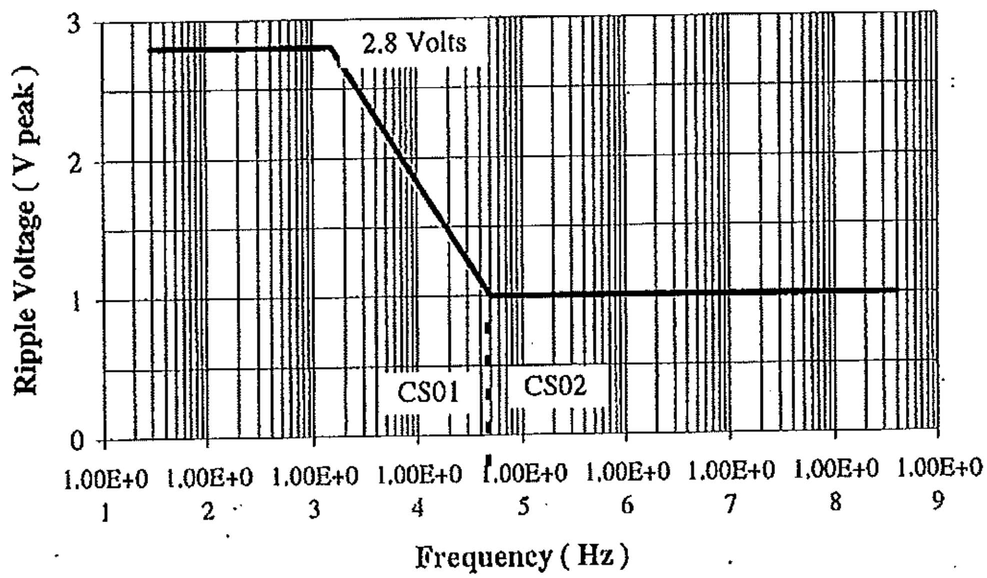


*Figure 5-44. Equipment Conducted Susceptibility Level (CS01, CS02)*

## 5.3 Software Applications

The ICESat bus does not directly share software with the payload. The payload is expected to contain its own DPU with data compression, coding, and packet capabilities commensurate with the ICESat bus.

Command capability of the payload can be by means of 1553, via the SCC, or directly using high- and low-level discrete command pulses, via the spacecraft CTU. Housekeeping telemetry of the payload is passed to the spacecraft CTU and may include up to 8 analog telemetry points and 12 thermistor telemetry points.

Payload data is passed from the payload DPU to the spacecraft SSR, which interfaces with the SCC via 1553. The SSR provides [redacted] Gbit of memory for data storage. Input/output data format is Non-Return to Zero Level (NRZL). Commanding to the SSR for recording and playback (simultaneous record/playback capability) is achieved via 1553.

ICESat flight software shall be capable of commanding the GLAS payload over the 1553 interface. GLAS commands shall be capable of execution either autonomously/synchronously or asynchronously via realtime or stored command. The flight software can be designed to ask for payload housekeeping telemetry at a specified rate. Asynchronous 1553 messages which the flight software would not be required to send autonomously can be uplinked and stored by the flight software and issued to the payload upon realtime or stored command.

## 5.4 Payload Environmental Requirements

Development of payload environmental requirements will be a coordinated effort between Ball and the payload developer to ensure overall spacecraft system compatibility.

Information contained in the Ball document 536971 entitled *Environmental Design and Test Specification* will be used as a starting point for the development of these requirements. Ball document 536971 contains structural, thermal vacuum, EMI/EMC, magnetic radiation exposure, single-event effects, and ESD design requirements.

The GLAS instrument shall remain bagged and purged at all times prior to Observatory integration to assure a Class 1,000 environment. During and after integration, the Observatory shall be maintained in a Class 10,000 clean environment, while all handling and personnel requirements affecting GLAS shall be in accordance with Class 1,000. The GLAS instrument shall be kept in a climate-controlled environment maintained between 18 - 24° C, at 30 - 50% relative humidity.

Further detail is included in CDRL 17, ICESat Contamination/Cleanliness Control Plan.

## 5.5 Safety

Each mission-specific system, including payloads, will be assessed for safety. Safety requirements will be identified to the payload developers based on the results of the safety assessment. Hazard control approaches will be coordinated between Ball and the payload developers to ensure overall spacecraft system compliance with applicable requirements.

The Ball document SP0031A-014 entitled *Reliability, Parts, and System Safety Handbook* may be used by the payload developer as a guideline for overall spacecraft system compliance.

~~In the area of p~~Personnel safety~~,~~ requirements are in accordance with EWRR 127-1, Eastern and Western Range Requirements~~ provides detailed requirements for meeting safety objectives~~.

ICESat shall be demonstrated by analysis to reenter within 25 years of mission conclusion. Based on Ball experience, no part of the ICESat bus is likely to survive reentry.

ICESat shall immediately detect and flag via telemetry the hazardous condition "Laser On" based on any one of the following situations:

- Power On commanded to any one of the laser busses
- Voltage detected on any one of the laser busses
- Current detected on any one of the laser buses

Safety plans for spacecraft operations during I&T are described in the safety section of CDRL 6, ICESat Spacecraft and Observatory I&T Plan.

## 5.6 Ground Support Equipment

Ground Support Equipment (GSE) for the payload subsystem testing is the responsibility of the payload developer. Once integrated into the spacecraft bus, Ball EGSE will be used for payload testing.

Ball EGSE is referred to as a platform simulator, which has capabilities that go beyond the standard command/telemetry related functions. A general description of these capabilities is included herein.

Specific elements of the GLAS GSE shall be handled to the same cleanliness handling as described in Section 5.4.

[redacted]

- [redacted]
- [redacted]

- [redacted]
- [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

| Electrical-Support-Item | Manufacturer | Status | Heritage |
|---|---|---|---|
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] |

~~*Figure 5-47. TOCC Components, Heritage & Status*~~

The following sections provide a brief description of each of the TOCC components.

### *Spacecraft Test Operations Console (STOC)*

The System Test Operations Console is the focal point of the TOCC system. It is used to send commands and receive telemetry data from the spacecraft. The STOC is based upon a Force Sparc CPU within a VME chassis along with associated peripherals. Software resides in the STOC that allows the user to send commands to the spacecraft in a user-friendly syntax which in turn is converted to the command bit streams that the spacecraft's command system recognizes. Conversely, the telemetry bit stream sent down from the spacecraft is converted to user-friendly graphical displays that the user can view on one of two monitors that are used for display interfaces. This system supports the automated test procedure system developed on GFO that allows automated testing of the spacecraft.

### *Power Control Console (PCC)*

The Power Control Console comprises all the hardware and software necessary to monitor, control, and analyze the power subsystem of the spacecraft bus it is connected to. These functions are performed by means of a computer connected to a control console through an Ethernet interface. Command, monitor, display, and analysis functions are performed using Labview graphical interface software. Also provided are flight command tone encoding and hard line telemetry interface functions as well as fail-safe circuits with remote shutdown provisions.

[redacted]

### Attitude Control Console (ACC)

[redacted]

### Remote Ground Terminal (RGT) / RF Console

[redacted]

[redacted]

### Solar Array Simulator (SAS)

[redacted]

### Battery Conditioning Console (BCC)

[redacted]

### Battery Arming Plug Simulator (BAPS)

[redacted]

### Bus Diagnostics Box

[redacted]

[redacted]

*GPS Antenna and LNA*

[redacted]

### 5.6.3 Handling of GLAS GSE

GSE for GLAS handling and testing operations at Ball will be moved, stored, and used in accordance with the ICESat Contamination/Cleanliness Control Plan. This plan will be coordinated with GSFC; sections dealing with GLAS and its GSE will be developed by GSFC. Equipment identified by GSFC will be bagged and purged at all times to assure a Class 1,000 clean environment. This equipment will be maintained in a Class 10,000 clean area, and handling and personnel requirements will be consistent with Class 1,000. Procedures adopted from the Goddard High Resolution Spectrograph and the Space Telescope Imaging Spectrograph programs done at Ball will be applied to the handling of alignment, calibration, and stimulation equipment for GLAS.

### 5.6.4 Payload to Bus GSE Interface

The interface between the payload GSE and the bus GSE shall be defined herein or in an ICD.

## 5.7 Operational Factors

Testing and certification of the ICESat mission operations system and personnel will be accomplished through end-to-end tests and simulations. End-to-end tests will be accomplished using both data tapes and the NASA Wallops compatibility van to validate the space link functionality. In addition, one nominal operation and two contingency simulations will be conducted with the EOC flight operations team, including BATC subsystem engineers and GSFC GLAS operations engineers, using resources similar to the end-to-end test. These simulations will be conducted to ensure planning timelines are reasonable and accurate. Special emphasis will be placed on demonstrating spacecraft/ground control system compatibility. Compatibility tests and mission simulations will provide the means to evaluate the mission operations team readiness for launch and on-orbit operations.

Pad operations are performed by the spacecraft integration and test (I&T) team in concert with the launch site ~~Delta~~ integration team using a subset of the equipment from integration and test. During pad and launch countdown operations the EOC team will coordinate activities with the integration and test team and the launch director. During countdown operations, the operators and ground systems are performing final spacecraft configuration, health and status monitoring, command and table loads, final system checks and data flows and voice reports. Activities are controlled by CSTOL procedures initiated by the I&T team at L-6 hours. Data flow and voice reports are defined in a countdown script compiled by the launch vehicle team. To accomplish this coordination several data and voice circuits are required:

- Telemetry Interface: Telemetry data from ICESat is provided to the EOC and the integration and test team during final spacecraft configuration (T-6 hours prior to launch) through a T-0 umbilical interface with the launch vehicle.
- Command Interface: Primary command responsibility rests with the I&T team and is performed through the umbilical interface. The EOC can command the spacecraft through the umbilical interface during prelaunch testing and as a backup to the integration and test team during launch countdown operations.
- Voice Interface: Voice systems are provided between the EOC and various ground support facilities. Also, launch countdown voice loops are provided to all facilities to monitor launch countdown activities.

BATC subsystem engineers will support I&T personnel at the launch site while operations engineers support the EOC. Following launch, subsystem engineers will provide additional support to the EOC through commissioning, with substantial support provided through the 90-day calibration orbit and first-time mission occurrences, such as yaw transitions.

Flight software maintenance is described in the MIS, Section 11. Additional information relating to flight operations is included in CDRL 10, Flight Operations Support Plan.

### 5.7.1 Test Scenarios

Payload testing is the responsibility of the payload developer. Payload bus integration test procedures and scenarios are a joint responsibility of both the payload developer and Ball. The Ball document SP0031A-004 entitled [redacted] *Test Plan* may be used as a starting point in defining payload/bus integration.

### 5.7.2 Commanding

The spacecraft bus provides

- Command uplink rate of [redacted]
- The ability to process up to [redacted] commands per second.
- Command storage memory with capacity to store [redacted] Time-tagged execution of stored commands to within [redacted]
- Command interface to the payload consists of
  - ~~8 HLD commands~~ [redacted]
  - 1553B narrow-band serial digital interface

### 5.7.3 Telemetry Recovery

The spacecraft bus provides

- [redacted] data storage for payload housekeeping and meta data
- Telemetry downlink rate of [redacted]
- [redacted]
- Telemetry interface from the payload consists of
  - 8 analog signals
  - 12 thermistor signals
  - 1553B narrowband serial digital interface
- [redacted] playback rate
- [redacted] band data downlink rate

### ~~5.7.4 Operational Duty Cycle~~

~~The operational duty cycle of the payload is governed by four factors: available on-orbit power, data storage capacity provided by the spacecraft bus SSR, the payload wideband downlink data rate, and the spacecraft/ground station contact geometries.~~

~~The spacecraft bus provides~~

- [redacted]

~~Although specific numbers for on-orbit power are mission specific, a general or first order discussion on power availability can be found in Section 5.2.4.~~

# ATTACHMENT C
# NAS5-97251, Delivery Order #3
# ICESAT (LAM)

## ICESAT (LAM)
## Interim Performance Based Payment Events
## and Completion Criteria

# Section 3. Interim Proposed Payment Events and Completion Criteria

[redacted]

[redacted]

# ATTACHMENT D
# NAS5-97251, Delivery Order #3
# ICESAT (LAM)

## ICESAT (LAM)
## Payment Schedule

Attach D

| # | Milestone Description | Mos ARO | M/S Paymt % | Payment Amount | Cumulative Payment |
|---|---|---|---|---|---|
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | | [redacted] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | [redacted] | | [redacted] | | [redacted] |
| [redacted] | | [redacted] | [redacted] | [redacted] | [redacted] |
| | [redacted] | | [redacted] | | [redacted] |

# ATTACHMENT E
# NAS5-97251, Delivery Order #3
# ICESAT (LAM)

## ICESAT (LAM)
## Contract Data Requirements List Supplement

**Title:**
Mission Requirements Document (MRD)

**CDRL No.:** 18

**Reference:**
Rapid Spacecraft Acquisition - Delivery Order #3

**Purpose:**
To formally detail mission-level requirements imposed on the spacecraft bus and provide a general reference guide for familiarizing program personnel.

**Related Documents:**
Geoscience Laser Altimeter System - Instrument Description Document
EOS/ICESat Spacecraft Performance Specification
EOS/ICESat Mission Implementation Specification

**Preparation Information:**

The MRD provides:

A. a central source to describe each mission segment, identification of the objectives of each segment, and description of the operations concepts.

B. identification of significant design constraints and assumptions that are mission drivers.

C. formal listing of major interface requirements that cross institutional, hardware, or jurisdictional boundaries.

| Title: Mission Requirements Document | CDRL No. : 18 |
|---|---|

**Reference:**
RSA - Request For Offer No. 3

**Purpose:**

To formally list and track all mission requirements.

**Related Documents:**
Geoscience Laser Altimeter System - GLAS: Instrument Description Document
24-Oct-97

EOS/ICESat Spacecraft Performance Specification

EOS/ICESat Mission Implementation Specification

**Preparation Information:**

The MRD provides:

A. a central source to describe each mission segment, identification of the objectives of each segment, and description of the operations concepts.

B. identification and tracking of significant design constraints and assumptions that are mission drivers.

C. formal listing and tracking of major interface requirements that cross institutional, hardware, or jurisdictional boundaries are also identified and tracked in the MRD.

[redacted]