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Topography Experiment (TOPEX) Software Document Series

Volume 6

TOPEX NASA Altimeter Operations Handbook

September 1992

TOPEX Contact:
David W. Hancock III

September 2003

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About the Series

The TOPEX Radar Altimeter Technical Memorandum Series is a collection of performance assessment documents produced by the NASA Goddard Space Flight Center Wallops Flight Facility over a period starting before the TOPEX launch in 1992 and continuing over greater than the 10 year TOPEX lifetime. Because of the mission's success over this long period and because the data are being used internationally to redefine many aspects of ocean knowledge, it is important to make a permanent record of the TOPEX radar altimeter performance assessments which were originally provided to the TOPEX project in a series of internal reports over the life of the mission. The original reports are being printed in this series without change in order to make the information more publicly available as the original investigators become less available to explain the altimeter operation and details of the various data anomalies that have been resolved.

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TOPEX NASA ALTIMETER OPERATIONS HANDBOOK

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FOREWORD

In preparing this Handbook, the TOPEX Radar Altimeter Flight User's Guide (Draft) was used liberally. The User's Guide is dated January 1990, and was produced by the Applied Physics Laboratory of Johns Hopkins University.

TOPEX NASA ALTIMETER
OPERATIONS HANDBOOK

1.0 INTRODUCTION

The user interfaces with the TOPEX radar altimeter by using commands telemetered to the TOPEX/POSEIDON spacecraft. The altimeter software interprets the commands to attain the user-desired operating state and, when sufficient time is allotted between commands, the commands are echoed in the telemetry from the spacecraft to the ground. The form, syntax and timing of these commands is crucial to the proper operation of the altimeter.

Commands are transmitted to the spacecraft by the Flight Control Team of the Flight Operations System (FOS) at JPL. The FOS also monitors the realtime performance and health of the spacecraft and sensors.

The TOPEX altimeter accepts two types of commands from the spacecraft: discrete commands and serial digital commands. Discrete commands open and close relays to control the supply of spacecraft power to parts of the altimeter and to override some fault detection circuitry. Serial digital commands supply data to the altimeter to open and close internal relays, to change the mode/operating state of the altimeter, or to change the value of some operating parameters or the programmed algorithms.

Serial digital commands are received on a serial interface and are routed internally to the Interface Control Assembly (ICA), the Adaptive Tracker Assembly (ATA), and the Power Subsystem.

The ICA commands perform the following functions:

- Reset the ATA processor
- Identify the reset type for the ATA
- Write protect/Unwrite protect blocks of ATA memory
- Enable/disable the watchdog timers
- Identify the ATA command mode for the ATA
- Protect the RF subsystem from bad commands while the processor initializes

The ATA commands perform the following functions:

- Change the altimeter operating mode
- Change some operating parameters
- Reprogram the ATA processor

The Discrete Commands open and close internal power relays, and relays that override current and fault protection circuitry.

The purpose of this document is to identify the altimeter commands, define their functions, and provide supplemental supporting material.

2.0 OPERATIONAL CONSTRAINTS

There are 32 form and sequence constraints when sending commands for the TOPEX altimeter. The constraint titles are listed below, followed by a Flight Constraint/Rule (FCR) for each.

FCR No. 1	Altimeter Side A or B Turn On
FCR No. 2	ALT/SSALT Operations Must Not Be Simultaneous
FCR No. 3	Applying Spacecraft +28V to Altimeter
FCR No. 4	Echoing of Multi-Word Commands
FCR No. 5	Execution of a Multi-Word Command
FCR No. 6	Multi-Word Command Mode Continuity
FCR No. 7	Input Bus Voltage Operational Limits
FCR No. 8	LVPS "ON" Command
FCR No. 9	Enable MTU +28V Prior to LVPS ON
FCR No. 10	No Science Data Available During Memory Load
FCR No. 11	Power-On Reset
FCR No. 12	Requirement for Primary Channel Select Command
FCR No. 13	Minimum Time Intervals Between Commands Within a Multi-Word Command
FCR No. 14	Minimum Time Intervals Between Single-Word Commands
FCR No. 15	ICA Command Following Power ON Reset
FCR No. 16	MTU Side Selection
FCR No. 17	28V MTU Timing Constraint
FCR No. 18	C-Band Amplifier Gate Enabling
FCR No. 19	Disable RF Gating Prior to Commanding TWTA Beam ON or CSSA ON
FCR No. 20	Signal Dwell During EMC Testing
FCR No. 21	Avoid Exposure of ALT to High Levels of Electromagnetic Energy
FCR No. 22	ALT Minimum Time in Vacuum Prior to Power Up
FCR No. 23	ALT Status During Thermal Vacuum Pump Down and Spacecraft Acoustic Testing

FCR No. 24	Low Voltage Power Supply Mode
FCR No. 25	Altimeter "OFF" Requirement
FCR No. 26	Watchdog Test Command of an ICA Command
FCR No. 27	Do Not Fully Power the TWTA During Spacecraft-Level Dynamic Environments
FCR No. 28	Altimeter will be OFF During Launch
FCR No. 29	FRU Warmup
FCR No. 30	Mode for Non OPs
FCR No. 31	S/C Attitude for Normal OPs
FCR No. 32	Minimum Time Interval After an ALT Memory Change

Additionally, there are two command-sequence operating rules:

1) If a command-transmission problem occurs within a Satellite Activity Block, restart the Block.

2) If there is a transmission failure during a multi-word command sequence, the recovery involves two possible scenarios:

   a. If the last command sent can be ascertained, resume the multi-word commanding from that point onward, regardless of the length of the time gap. This presumes that there has been no other commanding in the interim.

   b. If the last transmitted command cannot be determined, the steps are to a) reset to single-mode commanding, and b) then reinitiate the entire multi-word command sequence, including memory addresses and the multi-word commands.

   For a memory load, if just the commands within the multi-word command are reinitiated, they will be appended to whatever was previously loaded.

   For a parameter load, the software anticipates only a preset number of N commands, and it will assume that the Nth command is the file checksum, and will return error messages for the remaining parameters.

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Altimeter Side A or B Turn On **No:** 1

(Test/Flight)

Constraint: At no time shall both sides of the altimeter be "ON" simultaneously.

Rule: Always precede an altimeter side ON command with an OFF command for the other altimeter side.

Rationale: Receiver damage may occur if one side receives while the other is transmitting.

Exception Provisions: None

Means for Implementing Constraint: Inclusion of constraint in command sequences.

Author: ______________ **Date:** ______________

Approved by: ______________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: ALT/SSALT Operations Must Not Be Simultaneous **No:** 2

(Test/Flight)

Constraint: SSALT must remain unpowered unless the ALT is in the IDLE or OFF mode.

Rule: Do not power SSALT when ALT is operating in other than IDLE mode.

Rationale: Physical damage will most likely occur to SSALT.

Exception Provisions: None

Means for Implementing Constraint: Send SSALT OFF Cmd before commanding NRA from OFF or IDLE to any other mode.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Applying Spacecraft +28V to Altimeter **No:** 3

(Test/Flight)

Constraint: Anytime the +28V power relay to the ALT is switched ON, including recovery from SAFE HOLD, all ALT Power relays must first be commanded OFF and protection circuitry must be enabled.

Rule: Prior to commanding the S/C 28V power ON issue the following commands: ACSSAOFF, ATWTAOFF, AMT28OFF, ALVPSOFF, ABEAMOFF, AHLOTON, ATCOTON, ALVPSFEN, ACCOTON, IMAAAOFF, BCSSAOFF, BTWTAOFF, BMT28OFF, BLVPSOFF, BBEAMOFF, BHLOTON, BTCOTON, BLVPSFEN, BCCOTON, IMAABOFF.

Rationale: Avoid excessive current surges.

Exception Provisions: Voltage/current protection commands, A/B LVPSFEN, A/B HLOTON, A/B TCOTON, A/B CCOTON may be omitted with prior approval of ALT authority.

Means for Implementing Constraint: Incorporation of the above commands in a sequence to be followed each time power is applied.

Author: __________ **Date:** __________

Approved by: __________ **Date:** __________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Echoing of Multi-Word Commands **No:** 4

(Test/Flight)

Constraint: Allow a minimum of 2.000 seconds times the number of words in the Multi-Word Command prior to sending the subsequent Single-Word Command.

Rule: For multi-word command telemetry echoing, ensure that there is a minimum of 1.024 seconds times the number of words in the command prior to sending the subsequent single-word command.

Rationale: The entire multi-word command will be echoed in the engineering telemetry only if the interval between the last word of the multi-word command and the next ICA command returning the ATA to single-word command is greater than 1.024 seconds times the number of words in the multi-word command. At shorter intervals, the entire multi-word command will not be echoed.

Exception Provisions: If echoing of commands in TLM is not required, constraint can be ignored.

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Execution of a Multi-Word Command **No:** 5

Constraint: For proper execution, a Multi-Word Command must be followed by an appropriate ICA command. An appropriate ATA single-word command must then follow, except in the case of a memory patch.
Rule: Always follow a multi-word command with an appropriate ICA command to return to single-word command mode. Except after a memory patch, the ICA command is to be followed by an appropriate ATA single-word command.
Rationale: After a multi-word command has been loaded, it is executed only by either of the two single-word commands: "Execute Multi-word Command Buffer" or "Relocate Command Buffer." Sending the wrong single-word command will negate the multi-word load. A memory patch does not have to be executed.
Exception Provisions: None. Unless, for some reason, it is not desired to properly execute the multi-word command.
Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Multi-Word Command Mode Continuity **No:** 6

(Test/Flight)

Constraint: Do not return to Single-Word Command mode until after the Multi-Word Command is completed and proper single-word command has been sent.

Rule: The entire multi-word command must be loaded in Multi-Word Command mode (bit 11 of the ICA command word must remain = 0).

Also see TOPEX Flight Constraint/Rule #5 - Execution of a Multi-Word Command.

Rationale: Returning to Single-Word Command mode within a multi-word command terminates the multi-word command. The entire multi-word command will not be loaded or executed.

Exception Provisions: Except for emergency, with approval.

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________ **Date:** ______________

Approved by: ______________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Input Bus Voltage Operational Limits **No:** 7

(Test/Flight)

Constraint: The bus voltage input to the NASA altimeter must remain within operational limits (+23 to +35V).

Rule: Maintain the input bus voltage between +23 to +35 VDC.

Rationale: Required for proper operation. TWTA or LVPS may shut off outside of this range via self-protection features.

Exception Provisions: Consultation with and approval of ALT team.

Means for Implementing Constraint: Utilization of proper operational procedures and monitoring of data.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: LVPS "ON" Command **No:** 8

(Test/Flight)

Constraint: The satellite +28V power bus must be cycled OFF (unless already off), then cycled ON before issuing the LVPS ON Command.

Rule: Recycle the satellite +28V power bus (turn off and then back on) before an LVPS "ON" command is sent to the ALT:

- LVPS OFF
- S/C +28V OFF
- S/C +28V ON
- LVPS ON

Rationale: When LVPS turns off, a transient trips the overcurrent protection circuitry. In order to reset the overcurrent protection, the 28V power bus must be momentarily removed.

Exception Provisions: None

Means for Implementing Constraint: Incorporation of this constraint in the command sequence.

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Enable MTU +28V Prior to LVPS ON **No:** 9

(Test/Flight)

Constraint: The MTU +28V (side A or B as appropriate) must be enabled prior to an LVPS ON.

Rule: Prior to an LVPS ON Command, ensure that the proper (side A or B) MTU +28V is enabled.

Rationale: If the LVPS is commanded ON with the MTU +28V disabled, a current surge could occur, through the PSU exceeding the relay contact limits and tripping off the LVPS when the MTU +28V is next enabled.

Exception Provisions: None, except for emergency, with approval.

Means for Implementing Constraint: Utilization of proper operational procedures. Normal turn-on sequence should be followed.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
Advisory

Title: No Science Data Available During Memory Load **No:** 10

(Test/Flight)

Constraint: Science data are not generated during an altimeter memory load.

Rule: Do not take actions based on science data when in memory load mode.

Rationale: Memory uploading is performed in IDLE mode. Science data are not generated. Engineering data will be available.

Exception Provisions: None

Means for Implementing Constraint: N/A

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Power-On Reset **No:** 11

(Test/Flight)

Constraint: Following a Power-On reset, all uploaded parameters and memory uploads are lost.

Rule: Following a Power-On reset, retransmit any uploads required for operation.

Rationale: Following a Power-On reset, the flight software will reload all RAM tables from PROM and will begin executing the launch version of the flight software located in PROM. All uploaded programmable parameters and program segments are lost.

Power-On resets occur: at each power up, when specifically commanded, or when an error occurs and the ICA reset field is set to 00 (see Constraint #15 - ICA Command Following Power-On Reset).

Exception Provisions: If operation under original launch version of software is desired.

Means for Implementing Constraint: Monitor Power-On resets and reprogram as required.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Requirement for Primary Channel Select Command **No:** 12

(Test/Flight)

Constraint: The Primary Channel Select Command is required:

1) After an IDLE-to-STANDBY Transition
2) After a Parameter Table Select Command
3) After a C320 or C100 Select Command
4) After leaving C100 or C320 mode and returning to Ku or Ku/C
5) After a side change

Rule: Use the Primary Channel Select Command after any of the above conditions. It is required that MemBlk 1 be Unwrite Protected (ICA Cmd) before issuing the Primary Channel Select Command.

Rationale: Required for proper operation.

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Minimum Time Intervals Between Commands Within a Multi-Word Command **No:** 13

(Test/Flight)

Constraint: Successive multi-word commands must not be sent at intervals less than 56 ms.

Rule: Allow more than 56 ms intervals between successive commands within a multi-word command.

Rationale: In the multi-word command mode, the commands are stored in a multi-word buffer, until the multi-word command is executed. If, however, successive individual commands within a multi-word command are sent at an interval less than 56 ms (longest nominal track interval), the prior command will be written over in the ICA. In this case, the command sequence will not execute as desired.

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures. Use of No Op commands (DC02_CUNOOP) are required to maintain separation.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Minimum Time Intervals for Single-Word Commands **No:** 14

(Test/Flight)

Constraint: Allow a minimum of at least 2.000 seconds between ALT single-word commands and any other ALT commands, regardless of command type.

Rule: Single-word commands to the altimeter shall be separated by at least 1.024 seconds, before and after any other ALT commands, regardless of command type.

Rationale: In the single-word command mode, all new ATA commands are placed in a buffer and execution is delayed until just prior to the end of the current telemetry interval (~1.0152 seconds). If another command is received before the first is executed, the first may be overwritten.

ICA command timing is not affected by the flight software. However, if it is desired to see each ICA command echoed in telemetry, they must also be spaced at least 1.024 seconds apart.

Exception Provisions: Multi-word commands require only 56-ms intervals and that a single pause of 1.024 sec x the number of commands be made prior to the next ICA command (Constraint #13 - Minimum Time Intervals Between Commands Within a Multi-Word Command)

ICA commands may be sent faster but will be echoed only if the constraint is observed.

Means for Implementing Constraint: Incorporation of the constraint in command sequences.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: ICA Command Following Power-On Reset **No:** 15

(Test/Flight)

Constraint: After power up, the ICA Reset Type Field should be set to Error Reset (11) and not returned to Power-On reset (00) without concurrence of the ALT authority. The ICA command which does this must also set ATACMD Mode to single-word mode and select MTU, power Amp Gating, transmit enable, write protection and reset controls.

Rule: The ICA reset Type field should be set to Error Reset (11) after power up and only changed to allow reprogramming (01) or to return to operations from reprogram mode (10). Other fields should be set for operational requirements.

Rationale: The processor determines the type of reset by reading the reset type field of the last ICA command field. On power-up, all fields are initialized to 0. Unless the reset type field is changed by ICA command, all resets will be treated as power-on resets and, in the event of an error reset, the flight software will revert to its launch version, losing all uploads. See Constraint #11 - Power-On Reset.

Exception Provisions: Approval of ALT authority when it is not desired to retain uploads.

Means for Implementing Constraint: Sending proper ICA command immediately after power up or any power-on reset.

Author: ______________ **Date:** ______________

Approved by: ______________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: MTU Side Selection **No:** 16

(Test/Flight)

Constraint: After the initial ALT power-on, or after commanding ALT from IDLE to STBY, toggle to the proper MTU side selection (Bit 10 of the ICA command word).

Rule: After powering-on the ALT:
If Side A is desired, toggle Side A, then Side B, and then Side A.
If Side B is desired, toggle Side B, then Side A, and then Side B.

After commanding from Idle to Standby:
If Side A is desired, toggle Side B and then Side A.
If Side B is desired, toggle Side A and then Side B.

Rationale: After power-on, the switch toggling is performed for proper indication of the side powered.

After transitioning from IDLE to STBY, the LVPS voltage is too high in the IDLE mode to completely set the side select ferrite switch in a high isolation state. Damage will not occur but calibration data may be compromised by leakage signal.

Exception Provisions: None

Means for Implementing Constraint: Incorporation of this constraint in command sequence.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: 28V MTU Timing Constraint **No:** 17

(Test/Flight)

Constraint: Thirty seconds must have elapsed after the MTU +28V OFF Command prior to sending an LVPS OFF Command.

Rule: Following a MTU +28V OFF Command, allow a minimum of 30 seconds prior to sending an LVPS OFF Command.

Rationale: When turning off the 28V, a voltage lingers on the capacitor in the Ferrite switch circuitry which will allow the MTU to switch to an unwanted position in response to turn-off transients from the signal processor. This voltage must be given time to bleed off.

Exception Provisions: None

Means for Implementing Constraint: Incorporate this constraint in the command sequence.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: C-Band Amplifier Gate Enabling **No:** 18

(Test/Flight)

Constraint: On an ICA Command, the Transmit Enable must be ON whenever the C-Band Power Amplifier Gate is ON.

Rule: An ICA Command that enables the C-Band Power Amplifier Gate must also enable the Transmitter.

Transmit enable is ICA CMD Bit 8 (1 = Enable)

C Power Amp gate is Bit 9 (1 = Enable)

Rationale: If the C-Band Power Amplifier gate is enabled without also enabling the Transmitter, there will be a 19°C temperature rise in the channel amplifier which adversely affects parts reliability.

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Disable RF Gating Prior to Commanding TWTA Beam ON or CSSA ON **No:** 19

(Test/Flight)

Constraint: The RF gating has to be disabled prior to commanding the TWTA Beam ON or CSSA ON.
Rule: Do not enable the TWTA Beam or the CSSA while the RF gating is enabled.
Rationale: If the RF gating is enabled when the TWTA beam is ON or when the CSSA is ON, a current surge at input to CSSA and TWTA will be produced. Overcurrent protection will shut the units down.
Exception Provisions: None
Means for Implementing Constraint: Implementing constraint in CMD sequence.

Author: ________________ **Date:** ____________

Approved by: ________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Signal Dwell During EMC Testing **No:** 20

(Test Only)

Constraint: During EMC testing in which a signal is injected on the +28V power line, the injected signal shall not dwell at 1200 Hz or from 2100 to 2300 Hz for longer than 10 seconds.

Rule: Do not dwell the injected signal at 1200 Hz or 2100-2300 Hz during EMC testing.

Rationale: The altimeter's Low Voltage Power Supply (LVPS) natural resonance frequencies are approximately 1200 Hz and 2100-2300 Hz.

Exception Provisions: None. Applicable to test only.

Means for Implementing Constraint: Utilization of proper operational procedures during EMC/EMI testing.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Avoid Exposure of ALT to High Levels of Electromagnetic Energy **No:** 21

(Test Only)

Constraint: At no time shall the ALT be exposed to a high level of radar or radar transponder electromagnetic field at or near the operating frequency of 5.3 GHz or 13.6 GHz without placing receiver switches in a high isolation state.

Rule: C-Band radars (at Kourou) or nearby Ku-Band radars (at TBD) are not to operate unless the MTU receiver switches are in their high attenuation state.

The receiver switches are not to be placed in low isolation when there is any possibility of radiation from nearby Ku or C-band radars getting to the altimeter.

Rationale: A large, externally transmitted RF signal could damage the ALT receivers if the appropriate load attenuation has not been selected (applicable during launch checkout). ALT C-Band or Ku-Band channels could be damaged by radiation from C-band tracking radars or Ku-Band weather radars. Any mis-aimed or spurious signals coinciding with the 44-dB gain of the altimeter antenna could damage MTU pre-amplifiers.

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________ **Date:** ______________

Approved by: ______________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: ALT Minimum Time in Vacuum Prior to Power-Up **No:** 22

(Test/Flight)

Constraint: (1) During thermal vacuum testing, the TWTA should not be powered until the pressure is at or below 1×10^{-5} torr, and has been at or below 1×10^{-4} torr for at least 148 hours.

(2) Inflight, the TWTA should not be powered until a minimum of 336 hours after orbit insertion.

Rule: (1) During testing, ALT should not be turned on until 148 hours after the vacuum (at 0° or above) has been achieved.

(2) After launch, allow a minimum of 336 hours after orbit insertion prior to operating the altimeter.

Rationale: Due to outgassing of both the TWTA and surrounding objects after initiation of a vacuum environment, there is the possibility of damage to the NASA TWTAs due to high voltage arcing when local pressure reaches the critical area. (This applies to both vacuum testing and following launch.)

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: ALT Status During Thermal Vacuum Pump Down and Spacecraft Acoustic Testing **No:** 23

(Test Only)

Constraint: The ALT will be OFF during thermal vacuum pump-down or vacuum release and spacecraft pyro shock testing. The altimeter shall not be operated during thermal vacuum testing until a vacuum of 1×10^{-5} torr has been established for at least 96 hours.
Rule: Ensure that the ALT is OFF during vacuum pump-down and vacuum release and spacecraft pyro shock testing.
Rationale: Avoid corona discharge. TWTA/High-Voltage circuitry is susceptible to corona and arcing at pressures between ambient and 1×10^{-5} torr. Pyro shock testing is not meaningful for the altimeter.
Exception Provisions: None
Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: ~~Low Voltage Power Supply Mode~~ ***DELETED** **No:** 24

(Test/Flight)

Constraint: ~~**When the ALT is intended to be in IDLE Mode for an interval greater than five minutes, issue the MTU +28V OFF Command.**~~   ****DELETED****
Rule: If the ALT IDLE Mode is intended to be on for a period exceeding five minutes, issue the +28V MTU OFF Command.
Rationale: LVPS in IDLE mode is not properly loaded unless the +28V MTU is OFF. When the MTU +28V is ON during IDLE mode, over-voltage is applied to circuits, causing them to exceed their rating.
Exception Provisions: None
Means for Implementing Constraint: Utilization of proper operational procedures.

Deleted

Author: __________________ **Date:** ______________

Approved by: __________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Altimeter "OFF" Requirement **No:** 25

(Test/Flight)

Constraint: The S/C ALT +28V power must be OFF for the altimeter to be totally unpowered.

Rule: Turn the S/C +28V power to the altimeter OFF to remove all power draw by the altimeter when the altimeter is OFF.

Rationale: The spacecraft provides some power to the altimeter that is not controlled through the altimeter internal power relay. Therefore, even when all internal power relays are in the OFF state, there will be about 30 mA of current through the charging capacitor bleeder resistors in the LVPS and TWTA input circuits unless the S/C ALT +28V is powered off.

Exception Provisions: Discretion of Spacecraft Controller. No harm will result to ALT.

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________________ **Date:** ________________

Approved by: ______________________ **Date:** ________________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Watchdog Test Command of an ICA Command **No:** 26

(Test/Flight)

Constraint: Bit 12 (the Watchdog Test Command) of an ICA Command should be a 0 unless otherwise instructed by the altimeter authority.

Rule: Enable the Watchdog Test Command only with the concurrence of the NASA Wallops Flight Facility Altimeter team.

Rationale: Setting Bit 12 of an ICA Command may result in successive recurring resets. This was intended to implement a test mode in the altimeter.

No harm will occur to the ALT; however data will be lost.

Exception Provisions: Test may be conducted only with approval of ALT Team.

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Do Not Fully Power the TWTA During Spacecraft-Level Dynamic Environments **No:** 27

(Test Only)

Constraint: The TWTA will not be powered during spacecraft-level dynamic environments (acoustics or vibration).

Rule: Use an IDLE mode with TWTA unpowered during spacecraft-level dynamic environments.

Rationale: Instrument damage may otherwise occur.

Exception Provisions: None

Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Altimeter will be OFF During Launch **No:** 28

(Flight Only)

Constraint: The altimeter will be powered OFF during launch.

Rule: Ensure that the altimeter is unpowered during launch.

Rationale: Instrument damage may otherwise occur. Damage can occur from operation at critical pressure, or from vibrations on the powered TWT.

Exception Provisions: None

Means for Implementing Constraint: N/A

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
Advisory

Title: FRU Warmup **No:** 29

(Test/Flight)

Constraint: The FRU shall have been operating for at least 2 hours before quality altimeter data is expected during testing. The FRU shall have been operating for at least 24 hours continuously in orbit before quality altimeter data is expected.

Rule: Assure that FRU has been on for 2 hours before altimeter performance testing commences.

Assure that FRU has been on for 24 hours continuously in orbit before the altimeter is operated in a data taking mode.

Rationale: The stability and quality of the altimeter data is dependent on the stability and quality of the 5-MHz reference it receives from the FRU.

Exception Provisions: Operations can start immediately, but data quality cannot be assured.

Means for Implementing Constraint:

Author: ____________________ **Date:** ____________

Approved by: ____________________ **Date:** ____________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Mode for Non OPs **No:** 30

(Flight Only)

Constraint: When altimeter is not required to be taking data and it is desired that it not be tracking, altimeter should be put in IDLE mode or STANDBY. Turning the altimeter completely off should be avoided if possible.

Rule: IDLE mode should be used whenever it is desired that the altimeter not take data.

Rationale: The output power level of the C-band power amplifier stabilizes after about 200 hours with a drop of 0.3 to 0.2 dB. If the altimeter is turned completely off, the amplifier recovers and will have to restabilize.

Exception Provisions: Operation without stabilization is possible, but some degradation of science data may result.

Means for Implementing Constraint:

Author: ______________ **Date:** ______________

Approved by: ______________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: S/C Attitude for Normal OPs **No:** 31

(Flight Only)

Constraint: For normal operations, the altimeter will not produce quality science data until the s/c attitude control system has stabilized, and the altimeter electrical boresight axis is within 0.42 degree of the s/c nadir point.

Rule: Assure that the altimeter electrical boresight axis is being held within 0.42 degree of the s/c nadir point.

Rationale: Off-nadir pointing affects the accuracy of the altimeter measurements. Although this can be corrected with proper algorithms, these effects may no longer be easily corrected when this off-nadir point approaches the 3-db points of the altimeter antenna.

Exception Provisions: When special testing is being performed to test the attitude control system or to monitor altimeter off-nadir performance, this constraint does not pertain.

Means for Implementing Constraint: Monitoring of s/c attitude.

Author: ______________________ **Date:** ______________

Approved by: ______________________ **Date:** ______________

TOPEX/POSEIDON
FLIGHT CONSTRAINT/RULE (FCR)

Title: Minimum Time Interval After an ALT Memory Change **No:** 32

(Test/Flight)

Constraint: Allow adequate time for the completion of an ALT memory update prior to sending a write-protect command.
Rule: After an ALT memory change command (Execute Multi-word Command Buffer, Relocate Command Buffer, or Select Parameter Set), allow a minimum of 2.048 seconds prior to issuing the ensuing write-protect command.
Rationale: If insufficient time is available for the ALT memory updating, the implementation of the write-protect command may prematurely terminate the memory change process.
Exception Provisions: None
Means for Implementing Constraint: Utilization of proper operational procedures.

Author: ____________________ **Date:** ______________

Approved by: ____________________ **Date:** ______________

3.0 COMMANDS

3.1 Command Structure

The command mnemonic structure is defined as: XXYY_DZZZZZZZ

where XX = Command Type
DC = Discrete Command
SC = Serial Digital Command
CU = Central Unit Command

YY = Command Destination
42 = NASA Altimeter (ALT)

D = Altimeter Side Designator, A or B

ZZZZZZZ = Mnemonic

Command mnemonics are limited to 8 alpha-numeric characters (no special characters, like dash or underscore, no lower-case letters). They must begin with an alphabetic character (A-Z).

Discrete commands, which place the altimeter into a desired operating state, must begin with the character "A" or "B", to identify the altimeter side for which they are destined. The discrete commands and their mnemonics are listed in Table 3.1.

For commands that have NO parameters, each mnemonic corresponds to one bit pattern. This system is compatible with the ATA commands, since they have such a correspondence. Mnemonics will be assigned to the most commonly used ICA commands.

For commands WITH parameters, a single field within the command word, of variable width in bits, may be defined. Bits within the field may be defined dynamically, by passing the desired bit pattern as a parameter each time the mnemonic is used. To allow all possible ICA commands to be sent, we will create a mnemonic with a single 16-bit (the entire width of the command word) field. When this mnemonic is used, any 16-bit pattern may be sent to the ICA.

Two types of 16-bit serial commands are routed to the altimeter by the spacecraft. ICA commands are executed by the ICA, although they are read and reported in the telemetry by the flight software. ATA commands are read, executed, and reported by the flight software.

3.2 ICA Commands

3.2.1 ICA Format

Figure 3.2.1 illustrates the format of ICA commands. The five fields that impact the ATA operations are:

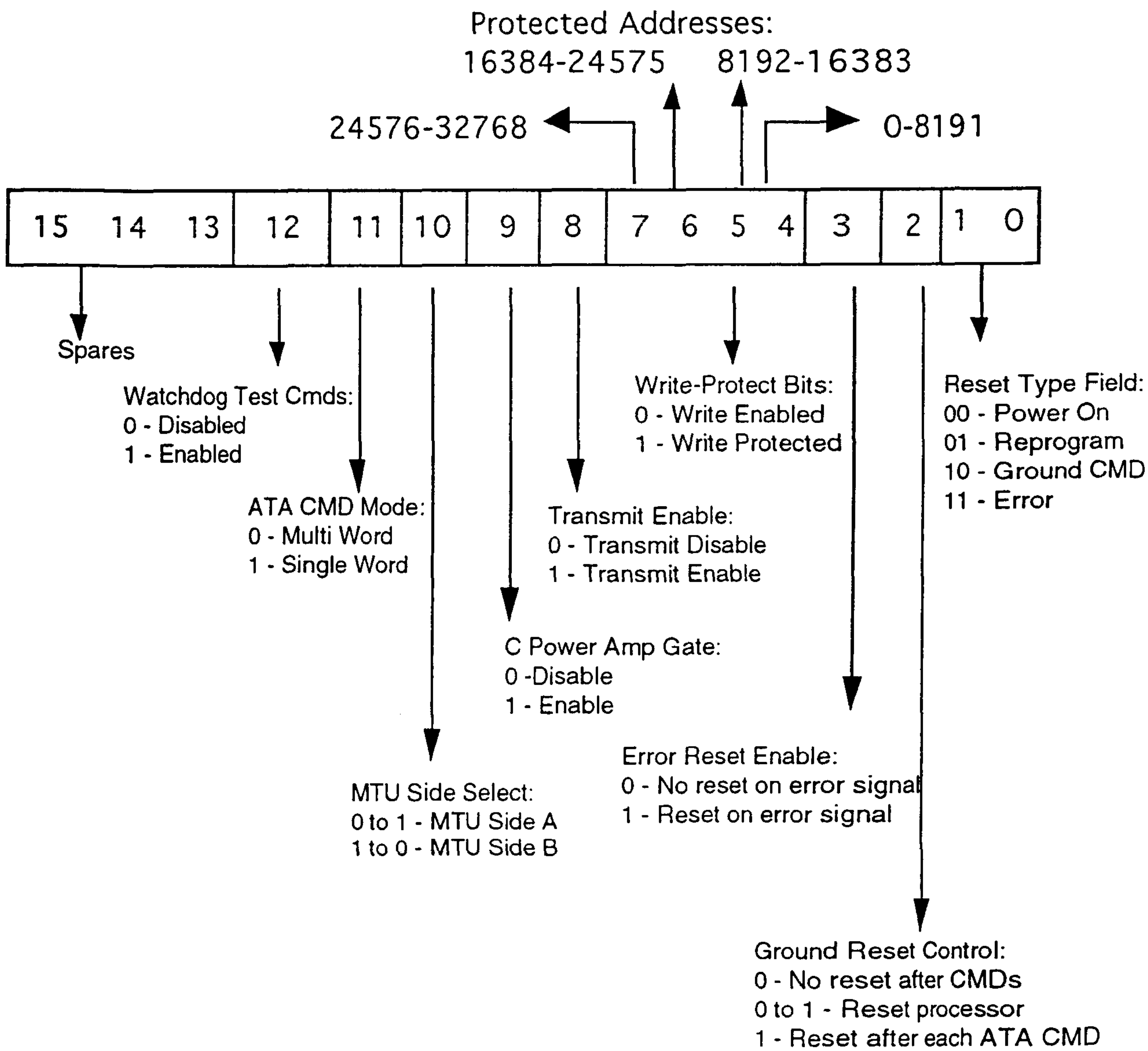
1) Bit 11 sets the ATA command mode to single word or to multi-word.

2) Bits 4 through 7 write-protect and un-write-protect blocks of RAM in the ATA. Several ATA commands require parts of RAM memory to be un-write protected before execution.

Table 3.1
Discrete Command Mnemonics for the ALT

RIU 7A/B DISCRETE COMMAND CHANNEL#	MNEMONIC	COMMAND
24	ALVPSON	LVPS-A ON
26	ALVPSOFF	LVPS-A OFF
28	AMT28ON	LVPS-A MTU +28V ENABLE
30	AMT28OFF	LVPS-A MTU +28V DISABLE
32	ALVPSFEN	LVPS-A FAULT ENABLE
34	ALVPSFOV	LVPS-A FAULT DISABLE
40	ATWTAON	TWTA-A POWER & FILAMENT ON
42	ATWTAOFF	TWTA-A POWER & FILAMENT OFF
44	ABEAMON	TWTA-A BEAM ON
46	ABEAMOFF	TWTA-A BEAM OFF
48	AHLOTON	TWTA-A HELIX OVERCURRENT TRIP ENABLE
50	AHLOTOFF	TWTA-A HELIX OVERCURRENT TRIP DISABLE
52	ATCOTON	TWTA-A CONVERTER OVERCURRENT TRIP ENABLE
54	ATCOTOFF	TWTA-A CONVERTER OVERCURRENT TRIP DISABLE
56	ACSSAON	CSSA-A ON
58	ACSSAOFF	CSSA-A OFF
60	ACCOTON	CSSA-A OVERCURRENT TRIP ENABLE
62	ACCOTOFF	CSSA-A OVERCURRENT TRIP DISABLE
1	BLVPSON	LVPS-B ON
3	BLVPSOFF	LVPS-B OFF
5	BMT28ON	LVPS-B MTU +28V ENABLE
7	BMT28OFF	LVPS-B MTU +28V DISABLE
9	BLVPSFEN	LVPS-B FAULT ENABLE
11	BLVPSFOV	LVPS-B FAULT DISABLE
17	BTWTAON	TWTA-B POWER & FILAMENT ON
19	BTWTAOFF	TWTA-B POWER & FILAMENT OFF
21	BBEAMON	TWTA-B BEAM ON
23	BBEAMOFF	TWTA-B BEAM OFF
25	BHLOTON	TWTA-B HELIX OVERCURRENT TRIP ENABLE
27	BHLOTOFF	TWTA-B HELIX OVERCURRENT TRIP DISABLE
29	BTCOTON	TWTA-B CONVERTER OVERCURRENT TRIP ENABLE
31	BTCOTOFF	TWTA-B CONVERTER OVERCURRENT TRIP DISABLE
51	BCSSAON	CSSA-B ON
53	BCSSAOFF	CSSA-B OFF
55	BCCOTON	CSSA-B OVERCURRENT TRIP ENABLE
57	BCCOTOFF	CSSA-B OVERCURRENT TRIP DISABLE

Figure 3.2.1
Structure of an ICA Command Word



3) If bit 3 is clear (=0) , error signals from the ATA watchdog timers will have no effect on the processor. If this bit is set (=1), an error signal from the ATA watchdog timer will cause an ATA processor reset.

4) While bit 2 is set (=1), the ATA processor will be reset after each command.

5) Bits 0-1 control no hardware, but are read by the ATA after a reset to determine what type of reset occurred. On power-up, these bits are cleared (=0), which is the code for a power-on reset. They must be explicitly loaded by ICA command with the code for any other type of reset. Reset types are discussed in section 3.2.2.

The ICA commands are listed in Table 3.2. For those ICA commands that have no parameters, each mnemonic corresponds to one bit pattern; such a system is compatible with the ATA commands. Care must be taken to not inadvertently change other bits when sending an ICA command for a specific purpose.

For ICA commands with parameters, a single mnemonic (ICACMD) has been created; when this mnemonic is used, any 16-bit pattern may be sent to the ICA.

3.2.2 Reset Types

There are four events that cause the flight processor to be reset: (1) power is applied to the processor, (2) a reset command is sent to the ICA, (3) the watchdog timers detect a timing error, and (4) the processor detects a processing error and requests a reset from the ICA. The effect of each type of reset on the processor is described in the following paragraphs.

The processor determines the type of reset by reading the last ICA command word from the ICA, and examining the Reset Type Field. On-power up, all the bits in the ICA Command word, including this field, are initialized to 0. "00" is the code for Power On reset. The Reset Type Field is not affected by any other hardware event besides power-on. Unless the Reset Type Field is explicitly changed by ICA command, all resets will be treated by the processor as Power On resets. Typically, the Reset Type Field should be loaded with the code for Error reset, prior to letting the altimeter run unattended for long periods of time; then, any resets will be treated as Error resets (since they were not commanded, they must be error resets). To place the altimeter in reprogram mode, the code for Reprogram reset must be placed in the Reset Type Field. Finally, if a ground command reset is needed (for example, to resume normal operations after reprogramming), the Reset Type Field must be set to Ground reset, so that the reset will be treated as a ground reset.

Following a Power On reset, the flight software will reload all RAM tables from PROM, and will begin executing the launch version of the flight software located in PROM. All unloaded programmable parameters and program segments are lost. Since the power-on condition clears the ICA command word, memory is unwrite-protected by the power-up. To protect the working tables in RAM, the RAM addresses 0-8191 should be write-protected, following a power-on reset, but unwrite-protected before issuing a PRIMKU/C ATA command. In the command sequences, addresses 8192-24576 are also protected, although they are not used in the flight version of the software. If new program segments are uploaded in the future, they will reside within this area, and should be protected. The clearing of the ICA command word at power-on also sets the command mode to multi-word. An ICA command must set the command mode to single word before commencing normal operations.

Following an Error reset, the flight software reinitializes only those counters, tables, etc. needed to begin operations in a known state. Uploaded programmable parameters and program segments are not written over from PROM; they are assumed to have been located in

Table 3.2

ICA Commands Codes and Mnemonics
Commands with NO Parameters:

ICA Command	Code	8-Character Mnemonic
Perform the following functions with MTU Side A Select:		
SETUP ATA With MTU Side A	0C7B	ASTART
ENABLE C POWER AMP, MTU Side A	0E7B	ACAMPON
ENABLE XMIT, NO C AMP MTU A	0D7B	AXMITON
FULL UP XMIT,MTU Side A; NO RESET TEST CMDS ALLOWED	0F7B	AFULLON
FULL-UP XMIT,MTU Side A; RESET TEST CMDS ALLOWED	1F7B	ATESTRST
WRITE ENABLE ADDR 0-8191; XMIT ENABLED	0F6B	AWENBLK1
WRITE ENABLE ADDR 0-8191; XMIT DISABLED	0C6B	AWB1XDIS
WRITE ENABLE ADDR 8192-16383	0F5B	AWENBLK2
WRITE ENABLE ADDR 16384-24575	0F3B	AWENBLK3
WRITE ENABLE ALL	0F0B	AWENALL
STNDBY/MULTIWORD CMD MODE; NO GROUND OR ERROR RESETS; SCRATCH-PAD ONLY WRT ENABLED	0670	AMULWCMD
IDLE/MULTIWORD CMD MODE; NO GROUND OR ERROR RESETS; SCRATCH-PAD ONLY WRT ENABLED	0470	AMULWIDL
RREPROGRAM MODE RESET; ALL RAM WRT ENABLED; NO ERROR RESETS	0605	ARPRGRST
MULTI-WORD CMD, REPROGRAM MODE; ALL RAM WRT ENABLED;	0601	AREPRGMW
SINGLE WORD CMD,REPROGRAM MODE; ALL RAM WRT ENABLED;	0E01	AREPRGSW
GROUND RESET; SCRATCH-PAD ONLY WRT ENABLED; SINGLE WORD CMD MODE	0E06	AGRNDRST
RESET ALT PROCESSOR	0C04	APROCRST
ERROR RESET PROCESSOR	0F7F	AERRORST
Perform the following functions with MTU Side B Select:		
SETUP ATA With MTU Side B	087B	BSTART
ENABLE C POWER AMP, MTU Side B	0A7B	BCAMPON
ENABLE XMIT, NO C AMP, MTU B	097B	BXMITON
FULL UP XMIT,MTU Side B; NO RESET TEST CMDS ALLOWED	0B7B	BFULLON
FULL UP XMIT,MTU Side B; RESET TEST CMDS ALLOWED	1B7B	BTESTRST
WRITE ENABLE ADDR 0-8191; XMIT ENABLED	0B6B	BWENBLK1

Table 3.2 (Continued)

ICA Commands Codes and Mnemonics
Commands with NO Parameters:

ICA Command	Code	8-Character Mnemonic
WRITE ENABLE ADDR 0-8191; XMIT DISABLED	086B	BWBLXDIS
WRITE ENABLE ADDR 8192-16383	0B5B	BWENBLK2
WRITE ENABLE ADDR 16384-24575	0B3B	BWENBLK3
WRITE ENABLE ALL	0B0B	BWENALL
STNDBY/MULTIWORD CMD MODE; NO GROUND OR ERROR RESETS; SCRATCH-PAD ONLY WRT ENABLED	0270	BMULWCMD
IDLE/MULTIWORD CMD MODE; NO GROUND OR ERROR RESETS; SCRATCH-PAD ONLY WRT ENABLED	0070	BMULWIDL
REPROGRAM MODE RESET; ALL RAM WRT ENABLED; NO ERROR RESETS	0205	BRPRGRST
MULTI-WORD CMD, REPROGRAM MODE; ALL RAM WRT ENABLED;	0201	BREPRGMW
SINGLE WORD CMD,REPROGRAM MODE; ALL RAM WRT ENABLED;	0A01	BREPRGSW
GROUND RESET; SCRATCH-PAD ONLY WRT ENABLED; SINGLE WORD CMD MODE	0A06	BGRNDRST
RESET ALT PROCESSOR	0804	BPROCRST
ERROR RESET PROCESSOR	0B7F	BERRORST

Commands WITH Parameter:

ICA Command	Code	8-Character Mnemonic	Parameter
SEND ANY POSSIBLE ICA COMMAND	none	ICACMD	(any 16-bit pattern) E.G., ICACMD 1900h

write-protected RAM and to be unaffected by the "error." The command saved in the Last_Mode_Com (MemBlk1) variable is executed, placing the altimeter in that mode. An attempt is made to write to the Last_Mode_Com variable each time a major operating mode command (Idle, Standby, Calibrate, or Track) is sent. If the segment of memory containing the Last_Mode_Com variable is unwrite-protected prior to sending major operating mode commands, then the ATA will return to the last commanded mode after an error reset. In the launch version of the flight software, no provision was made for the processor to detect its own errors; therefore, the processor never requests a reset from the ICA. Operationally, all error resets are generated by the watchdog timer. A test mode command can be used to force the ATA to request a reset.

A Ground reset is identical to an Error reset, except that the processor always enters Idle mode following a Ground reset.

Reprogram resets initialize only those variables associated with engineering telemetry, command input, and reprogramming. The program basically sits in a loop waiting to load new program segments.

3.3 ATA Commands

Each 16-bit ATA command will be interpreted by the flight processor as either a single-word command or as part of a multi-word command, based on the ATA Single/Multi-Word Command field in the last ICA command. The treatment of each type of command is described in the paragraphs below.

3.3.1 Single-Word Commands

Tables 3.3.1a and 3.3.1b define the single-word ATA commands. Table 3.3.1a identifies the mnemonics which are the same for the A and B sides. Table 3.3.1b identifies the code and indicates the valid operating modes for each command. If a single-word command is received in an invalid mode, or if a bit pattern not represented in Table 3.3.1b is received in single-word command mode, then the command will not be executed, and an error will be reported in the telemetry stream. It is also possible to issue a valid command (e.g., PRIMKU, EMLON), with MemBlk1 write-protected, and have the command not executed and without an error reported in the TLM.

The first four listed single-word commands, (IDLE, STANDBY, CALIBRATE and TRACK) are for mode assignment; these four mode commands and their expected results are described further in Appendix A. Test mode subsets of the altimeter mode commands are characterized in Appendix B.

3.3.2 Multi-Word Commands

There are three types of multi-word commands:

a. Parameter change

b. Reprogram change (memory load)
   - Load Source - DOS diskette
   - Command sequence
   - Timing
   - Verification

c. Memory dump address

The sequencing of these commands is:

a. Setup by series of serial commands (1.2-second spacing)
b. Change values (60-msec spacing C & DH controlled)
c. Implementation series of serial commands (1.2-second spacing)

If the Single/Multi-Word Command Field of the last ICA command is set to multi-word command mode, then the 16-bit ATA command will be added to the end of a buffer of the most recent group of multi-word commands. As the name implies, this mode is used to issue commands that require more than one word, such as uploading parameters. Under special circumstances, this mode is used to upload new program segments.

There are two stages to multi-word command execution. First, the entire command must be loaded in multi-word command; no additional words may be added to the buffer after returning to single-word command mode. When the multi-word command has been loaded, the processor is returned to single-word command mode, and a single-word command (Execute Command Buffer or Relocate Command Buffer in Table 3.3.1b) is issued which causes the multi-word command to be executed.

The ATA commands, with parameters (P_n), within a multi-word command are:

Mnemonic	Parameter Descriptor
SC42_ATASTART, P_n	Start Address
SC42_ATASTOP, P_n	Stop Address
SC42_ATACHKSM, P_n	File Checksum
SC42_ATAWD, P_n	File Word

Table 3.3.1a

Serial Command Mnemonics for the ALT

ESSC	Mnemonics (Sides A and B)	Ch.#	Command Description
IDLE	SC42_IDLE	70	ALT ATA IDLE CMD
STANDBY	SC42_STANDBY	70	ALT ATA STANDBY CMD
CAL	SC42_CAL	70	ALT ATA CALIBRATE CMD
TRACK	SC42_TRACK	70	ALT ATA TRACK CMD
FRZPRATT	SC42_FRZPRATT	70	ALT FREEZE PRIM CAL ATTENUATOR ON
UNFPRATT	SC42_UNFPRATT	70	ALT FREEZE PRIM CAL ATTENUATOR OFF
FRZSATT	SC42_FRZSATT	70	ALT FREEZE SEC CAL ATTENUATOR ON
UNFSATT	SC42_UNFSATT	70	ALT FREEZE SEC CAL ATTENUATOR OFF
HBIASON	SC42_HBIASON	70	ALT HEIGHT BIAS TEST ON
BHIASOFF	SC42_HBIASOF	70	ALT HEIGHT BIAS TEST OFF
FRZTRACK	SC42_FRZTRCK	70	ALT FREEZE TRACK ON (0112)
UNFTRACK	SC42_UNFTRCK	70	ALT FREEZE TRACK OFF
CSTTRACK	SC42_CSTTRCK	70	ALT COAST TRACK ON (0113)
UNCTRACK	SC42_UNCTRCK	70	ALT COAST TRACK OFF
THRSHON	SC42_THRSHON	70	ALT THRESHOLD-ONLY ON (0114)
THRSHOFF	SC42_THRSHOF	70	ALT THRESHOLD-ONLY OFF
EMLON	SC42_EMLON	70	ALT EML-ONLY ON
EMLOFF	SC42_EMLOFF	70	ALT EML-ONLY OFF
FINEON	SC42_FINEON	70	ALT FINE TRACK ONLY ON
FINEOFF	SC42_FINEOFF	70	ALT FINE TRACK ONLY OFF
COARSON	SC42_COARSON	70	ALT COARSE TRACK ONLY ON
COARSOFF	SC42_COARSOF	70	ALT COARSE TRACK ONLY OFF
PRIMKU	SC42_PRIMKU	70	ALT PRIMARY CHANNEL KU
PRIMC	SC42_PRIMC	70	ALT PRIMARY CHANNEL C
KUON	SC42_KUON	70	ALT KU CHANNEL ON
KUOFF	SC42_KUOFF	70	ALT KU CHANNEL OFF
CON	SC42_CON	70	ALT C CHANNEL ON
COFF	SC42_COFF	70	ALT C CHANNEL OFF
HRATEKU	SC42_HRATEKU	70	ALT HIGH RATE WAVEFORMS KU
HRATEC	SC42_HRATEC	70	ALT HIGH RATE WAVEFORMS C
ISCANON	SC42_ISCANON	70	ALT INTERFERENCE SCAN ON
ISCANOFF	SC42_ISCANOF	70	ALT INTERFERENCE SCAN OFF
HXMITON	SC42_HXMITON	70	ALT HIGH RESOLUTION XMIT TEST ON
HXMITOFF	SC42_HXMITOF	70	ALT HIGH RES0LUTION XMIT TEST OFF
LXMITON	SC42_LXMITON	70	ALT LOW RESOLUTION XMIT TEST ON
LXMITOFF	SC42_LXMITOF	70	ALT LOW RESOLUTION XMIT TEST OFF
C320	SC42_C320	70	ALT C BANDWIDTH 320 MHZ
C100	SC42_C100	70	ALT C BANDWIDTH 100 MHZ
PARM1	SC42_PARM1	70	ALT PARAMETER SET 1
PARM2	SC42_PARM2	70	ALT PARAMETER SET 2
PARM3	SC42_PARM3	70	ALT PARAMETER SET 3
PARM4	SC42_PARM4	70	ALT PARAMETER SET 4
NOBRST	SC42_NOBRST	70	ALT INHIBIT BURST RATE WORD RESET
EXTRBRST	SC42_EXTRBRS	70	ALT INSERT EXTRA BURST WORD RESET

Table 3.3.1a
(continued)

Serial Command Mnemonics for the ALT

ESSC	Mnemonics (Sides A and B)	Ch.#	Command Description
NOTRK	SC42_NOTRK	70	ALT INHIBIT TRACK RATE WORD RESET
EXTRTRK	SC42_EXTRTRK	70	ALT INSERT EXTRA TRACK WORD RESET
RQSTRST	SC42_RQSTRST	70	ALT REQUEST RESET
EXECBUFR	SC42_EXECBUF	70	ALT EXECUTE MULTIWORD COMMAND BUFFER
LOCBUFR	SC42_LOCBUFR	70	ALT RELOCATE COMMAND BUFFER
DUMPLMT	SC42_DUMPLMT	70	ALT MEMORY DUMP LIMITS
PARMSET	SC42_PARMSET	70	ALT PARAMETER SET UPLOAD
BUFRADR	SC42_BUFRADR	70	ALT NEW COMMAND BUFFER ADDRESS
ICACMD	SC42_ICACMD	70	ALT 16 BIT VARIABLE ICA COMMAND

Table 3.3.1b
ATA Command: Valid Command Code and Modes

Single-Word Command	Code	IDLE	STANDBY	CAL I	CAL II	COARSE ACQ	CORSE TRACK	FINE ACQ	FINE TRACK	REPROGRAM
IDLE	1003	X	X	X	X	X	X	X	X	
STANDBY	1006	X	X	X	X	X	X	X	X	
CALIBRATE	100C	X	X							
TRACK	1018	X	X							
FREEZE PR CAL ATTENUATOR ON	0111		X	X	X					
FREEZE PR CAL ATTENUATOR OFF	0011		X	X	X					
FREEZE SEC CAL ATTENUATOR ON	0110		X	X	X					
FREEZE SEC CAL ATTENUATOR OFF	0010		X	X	X					
HEIGHT BIAS TEST ON	0129		X	X	X					
HEIGHT BIAS TEST OFF	0029		X	X	X					
FREEZE TRACK ON	0112		X			X	X	X	X	
FREEZE TRACK OFF	0012		X			X	X	X	X	
COAST TRACK ON	0113		X			X	X	X	X	
COAST TRACK OFF	0013		X			X	X	X	X	
THRESHOLD-ONLY ON	0114		X			X	X	X	X	
THRESHOLD-ONLY OFF	0014		X			X	X	X	X	
EML-ONLY ON	0115		X			X	X	X	X	
EML-ONLY OFF	0015		X			X	X	X	X	
FINE TRACK ONLY ON	0117		X							
FINE TRACK ONLY OFF	0017		X							
COARSE TRACK ONLY ON	0116		X							
COARSE TRACK ONLY OFF	0016		X							
PRIMARY CHANNEL KU	0121		X							
PRIMARY CHANNEL C	0021		X							
KU CHANNEL ON	0122		X							
KU CHANNEL OFF	0022		X							
C CHANNEL ON	0123		X							
C CHANNEL OFF	0023		X							
HIGH RATE WAVEFORMS KU	0125	X	X				X		X	
HIGH RATE WAVEFORMS C	0025	X	X				X		X	
INTERFERENCE SCAN ON	0126		X							
INTERFERENCE SCAN OFF	0026		X							
HIGH RESOLUTION XMIT TEST ON	0127		X							
HIGH RESOLUTION XMIT TEST OFF	0027		X							
LOW RESOLUTION XMIT TEST ON	012A		X							
LOW RESOLUTION XMIT TEST OFF	002A		X							
C BANDWIDTH 320 MHZ	0028		X							
C BANDWIDTH 100 MHZ	0128		X							

Table 3.3.1b (continued)
ATA Command: Valid Command Code and Modes

Single-Word Command	Code	Valid Modes: IDLE	STANDBY	CAL I	CAL II	COARSE ACQ	CORSE TRACK	FINE ACQ	FINE TRACK	REPROGRAM
PARAMETER SET 1	1031		X							
PARAMETER SET 2	1032		X							
PARAMETER SET 3	1033		X							
PARAMETER SET 4	1034		X							
EXTRA WD TIMER BURST RESET	5002	X	X	X	X	X	X	X	X	
SKIP A WD TIMER BURST RESET	5001	X	X	X	X	X	X	X	X	
EXTRA WD TIMER TRACK RESET	5004	X	X	X	X	X	X	X	X	
SKIP A WD TIMER TRACK RESET	5003	X	X	X	X	X	X	X	X	
REQUEST A PROCESSOR RESET	5005	X	X	X	X	X	X	X	X	
EXECUTE MULTIWORD CMD BUFFER	1030	X	X							
RELOCATE COMMAND BUFFER	3180									X
Multi Word Command Identifiers		Valid Execution Modes (Loading valid in any mode)								
MEMORY DUMP LIMITS	6030	X	X							
PARAMETER SET UPLOAD	6300	X	X							
NEW COMMAND BUFFER ADDRESS	6180									X

Multi-word commands are composed of three parts: a command identifier, the body of the command, and a checksum. The command identifier is the first 16-bit word in each multi-word command. The code that executes the command buffer uses this word to decide what the multi-word command is. The body contains the uploaded data, etc., the parameter values in a parameter upload. The checksum follows the last data word. It is computed by adding the command identifier and each data word in the body of the multi-word command.

The multi-word command identifiers are shown in Table 3.3.1b, along with the modes in which multi-word command execution is value. Multi-word command loading is value in any mode.

3.4 Ancillary Altimeter Operations

Appendix C provides information for ancillary altimeter operations:

- Changing the Operating State
- Changing the Primary Channel
- Setting the High Rate Waveforms Bandwidth Assignment
- Changing the C-Band Bandwidth
- Turning on and off the Ku-band Channel
- Turning on and off the C-band Channel
- Changing the Parameter Set
- Loading a new Parameter Set
- Changing the Memory Dump Limits
- Reprogramming

3.5 Command Echoing

ATA and ICA command codes are echoed in Engineering Frame bytes m, m+1 and m+2 (where m = 2, 18, 34, 50, 66, 82, 98 or 114). The interpretation of the command code is described in Engineering Frame Note 1 on page 7-29.

4.0 ALT PRELIMINARY TURN ON/TURN OFF COMMAND SEQUENCES

The following sequences are provided to illustrate the kind of commanding (but not all possibilities) that will be needed to operate an altimeter, in this case altimeter side "A".

4.1 Initial Relay Commanding (Required Once)

ACSSAOFF
ATWTAOFF
AMT28OFF
ALVPSOFF
ABEAMOFF
AHLOTON
ATCOTON
ALVPSFEN
ACCOTON
IMAAAOFF
BCSSAOFF
BTWTAOFF
BMT28OFF
BLVPSOFF
BBEAMOFF
BHLOTON
BTCOTON
BLVPSFEN
BCCOTON

4.2 Initial Alt "A" Turn On

```
NO 28V MAIN BUS POWER TO ALTIMETER:  ALTIMETER/POWER---OFF
:ALT B OFF TELLTALE CHECKS
 TELLTALE CHECK ATTBEAMB=0
 TELLTALE CHECK ATTCSSAB=0
 TELLTALE CHECK ATTTWTAB=0
 TELLTALE CHECK ATTLVPSB=0
 TELLTALE CHECK ATTHLOTB=1
 TELLTALE CHECK ATTTCOTB=1
 TELLTALE CHECK ATTLVFEB=1
 TELLTALE CHECK ATTCCOTB=1
 TELLTALE CHECK ATTM28VB=0
:ALT A TURN ON WITH TELLTALE CHECKS
 TELLTALE CHECK ATTCSSAA=0
 TELLTALE CHECK ATTTWTAA=0
 TELLTALE CHECK ATTLVPSA=0
 TELLTALE CHECK ATTBEAMA=0
 TELLTALE CHECK ATTHLOTA=1
 TELLTALE CHECK ATTTCOTA=1
 TELLTALE CHECK ATTLVFEA=1
 TELLTALE CHECK ATTCCOTA=1
 TELLTALE CHECK ATTM28VA=0
28V MAIN BUS POWER TO ALTIMETER SIDE "A";ALTIMETER\POWER--ON
DELAY 1000                    :1 SEC.
AMT28ON
DELAY 18000                   :18 SEC.
TELLTALE CHECK ATTM28VA=1
ALVPSON
DELAY 18000                   :18 SEC.
TELLTALE CHECK ATTLVPSA=1
ASTART:ICA CMD 0C7B           :SET UP FOR MTU SIDE "A" SELECTION
DELAY 10000                   :10 SEC.
BSTART:ICA CMD 087B           :TO TOGGLE TO MTU SIDE "A" THE
                              :ASTART CMD MAY NOT BE NECESSARY
                              :IF THE NEXT ICA CMD(e.g;AWB1XDIS/:
                              :ICA CMD 086B) WILL TRANSITION THE
                              :MTU SELECT BIT TO A LOW "O".
DELAY 10000                   :10 SEC.
AWB1XDIS: ICA CMD 0C6B
DELAY 10000                   :10 SEC.
IDLE: ATA CMD 1003
DELAY 10000                   :10 SEC.
ASTART:ICA CMD 0C7B
ATWTAON                       :NOTE: THERE IS A 220 SECOND DELAY
                              :TIMER THAT SHOULD BE ALLOW TO TIME
                              :OUT BEFORE ISSUING THE "ABEAMON"
                              :RELAY COMMAND
DELAY 18000                   :18 SEC.
TELLTALE CHECK ATTTWTAA=1
ACSSAON
DELAY 18000                   :18 SEC.
TELLTALE CHECK ATTCSSAA=1
:NOW/IN/FULL/IDLE/MODE
```

4.3 Alt "A" Operational Cmd'ing from Idle to Standby

AWB1XDIS :ICA CMD 0C6B :REQUIRED UNWRITE PROTECT FOR PRIMKU CMD
DELAY 10000 :10 SEC.
STANDBY:ATA CMD 1006
DELAY 10000 :10 SEC.
APRIMKU: ATA CMD 0121 :OR PRIMC
DELAY 10000 :10 SEC.
ABEAMON :>220 SEC. AFTER THE "ATWTAON" CMD
DELAY 18000 :18 SEC.
TELLTALE CHECK ATTBEAMA=1
AFULLON:ICD CMD 0F7B
:NOW/IN/STAND BY/MODE

4.4 Alt "A" Operational Cmd'ing from Standby to Track

AWENBLK1:ICA CMD 0F6B :FOR RESET ON ERROR TO TRACK ENABLE XMTRS
DELAY 10000 :10 SEC.
TRACK:ATA CMD 1018
DELAY 10000 :10 SEC.
:WHILE IN THE TRACK MODE ISSUE THE FOLLOWING ICA CMD
AFULLON:ICA CMD 0F7B :FULL UP XMIT/TO WRITE PROTECT MEMORY BLK 1
:NOW/IN/TRACK/MODE

4.5 Alt "A" Operational Cmd'ing from Track to Standby

AWENBLK1:ICA CMD 0F6B :RESET ON ERROR TO STANDBY (OPT.)
DELAY 10000 :10 SEC.
STANDBY:ATA CMD 1006
DELAY 10000 :10 SEC.
AFULLON:ICA CMD 0F7B
:NOW/IN/STANDBY/MODE

4.6 Cmd Alt "A" from Stby to Idle

ABEAMOFF
DELAY 18000 :18 SEC.
TELLTALE CHECK ATTBEAMA=0
AWB1XDIS:ICA CMD 0C6B :UNWRITE PROTECT/NO XMIT (TBD NEW CMD)
DELAY 10000 :10 SEC.
IDLE :ATA CMD 1003 :FERRITE SW TO MAX. ATTENUATION
DELAY 10000 :10 SEC.
ASTART:ICA CMD 0C7B :DISABLE XMITTERS/WRITE PROTECT
NOW/IN/IDLE/MODE

4.7 Cmd Alt "A" from Idle to Off

ACSSAOFF	
DELAY 18000	:18 SEC.
TELLTALE CHECK ATTCSSAA=0	
ATWTAOFF	
DELAY 18000	:18 SEC.
TELLTALE CHECK ATTTWTAA=0	
AMT28OFF	
DELAY 18000	:18 SEC.
TELLTALE CHECK ATTM28VA=0	
DELAY 42000	:60 SEC. FOR FERRITE SW BLEED OFF :AFTER AMT28OFF CMD
ALVPSOFF	
DELAY 18000	:18 SEC.
TELLTALE CHECK ATTLVPSA=0	
IMAAAOFF	: ALTIMETER\POWER ..OFF
ALTIMETER\"A"\IS\NOW\OFF	

4.8 Alt "A" Operational Cmd'ing from Standby to Calib

AWENBLK1:ICA CMD 0F6B	:ENABLE RESET ON ERROR TO NEXT ATA CMD :(CALIBRATE)ENABLE XMTRS
DELAY 10000	:10 SEC.
CAL:ATA CMD 100C	
DELAY 2000	:2 SEC.
WHILE IN THE CALIBRATE MODE ISSUE THE FOLLOWING CMDS	
AFULLON:ICA CMD 0F7B :FULL	UP XMIT/TO WRITE PROTECT MEMORY BLK I
DELAY 240000	:4 MINUTES
AWENBLK1:ICA CMD 0F6B	:ENABLE RESET ON ERROR TO NEXT ATA CMD :(STANDBY) ENABLE XMTRS
DELAY 10000	:10 SEC.
STANDBY	
DELAY 10000	:10 SEC.
AFULLON:ICA CMD 0F7B :FULL	UP XMIT/TO WRITE PROTECT MEMORY BLK I
:NOW/IN/STANDBY/MODE	

5.0 PARAMETER VALUES

The preliminary values for parameter set 1 are listed in Table 5.0, from the TOPEX Radar Altimeter Flight Software Design document (1991). The role of discrete parameters in controlling the ALT tracker is depicted in Figure 5.0. Selected parameter descriptions are as follows.

5.1 Interference Scan Parameters

An Interference Scan begins at the Interference Scan Minimum Height. For each track interval, the height is incremented by the Interference Scan Height Increment, until the Interference Scan Maximum Height is reached.

5.2 Cal-I Index1, Index2

During Cal-I, the two waveform samples indexed by Cal-I Index1 and Index2 (zero origin indexing) will be averaged to obtain the AGC Gate. The ratio of the difference of these two waveform samples to their sum will be used to calculate the height error.

5.3 Cal-I Minimum AGC

During Cal-I, the Ku and C AGC gates will be compared to the Cal-I Ku and C AGC Minimum. If the AGC gate on a channel exceeds that channel's minimum, then the height error will be used for tracking on that channel. Otherwise, no tracking will be performed on that channel.

5.4 Cal-I AGC Threshold

This parameter sets the AGC threshold used in tracking the AGC during Cal-I. The AGC tracking loop should force the average of the waveform samples from Cal-1 Indexl to Index2 to equal the Cal-I AGC Threshold.

5.5 Cal-I Alphas

During Cal-I, Cal-I AGC Alpha is used to track AGC and the Cal-I Track Alpha is used to track height on both channels.

5.6 Cal-I Error Scales

The Cal-I Ku and C Height Error Scales change a 1-bit height error into the height scaling used by the height tracking loop and the synchronizer. The Cal-I AGC Error Scale scales a 1-bit AGC error into the scaling used by the AGC tracking loop and the synchronizer.

5.7 AGC Threshold

The tracking loop forces the average of the waveform samples used to form the AGC Gate to be approximately equal to the AGC Threshold. The same AGC Threshold and AGC gate indices are used in Track mode and in Cal-II, so that the noise estimate produced in Cal-II will be valid in track mode. In Coarse Acquisition, the signal must be larger than 1/4 the AGC Threshold to be recognized.

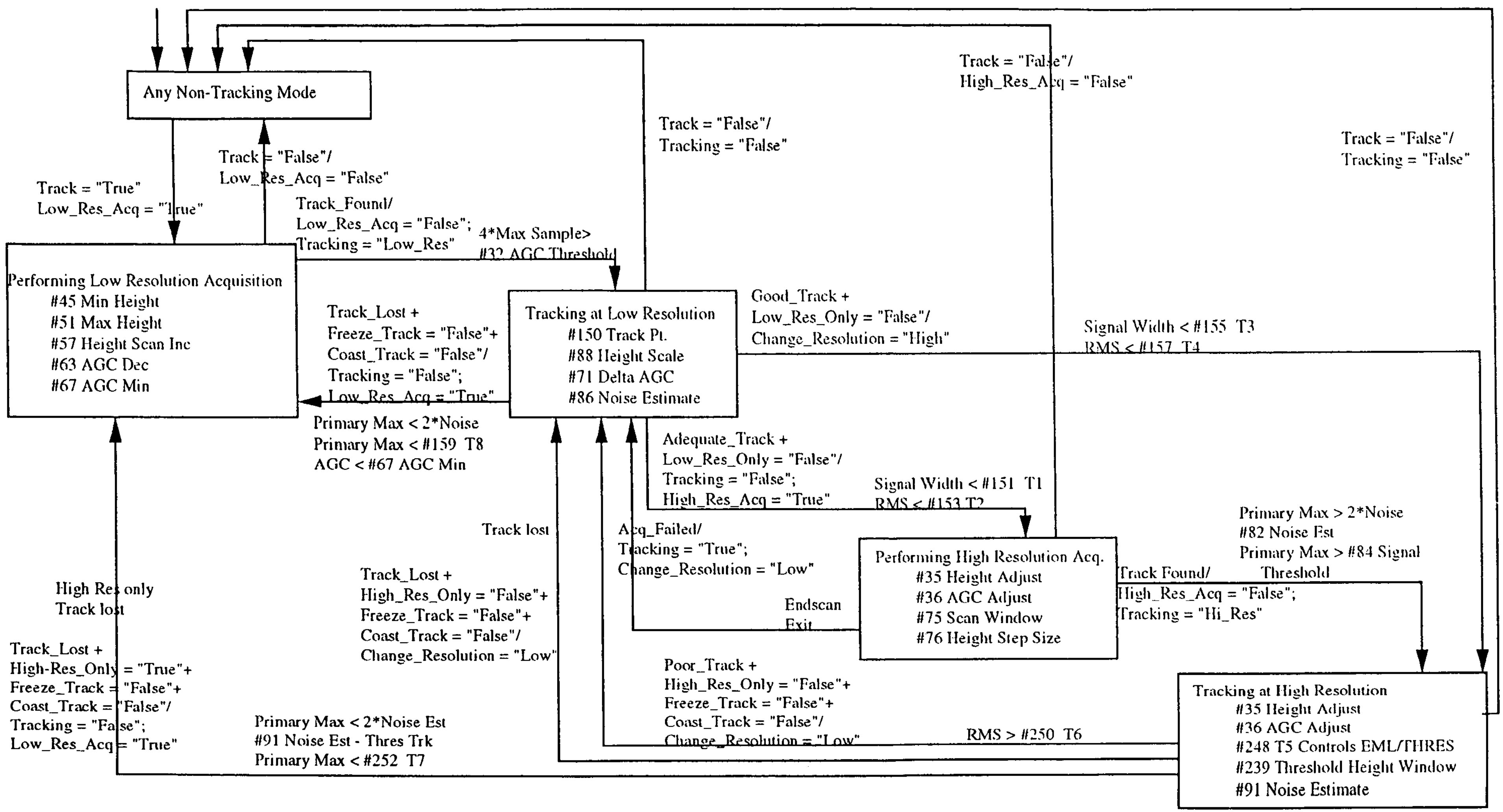


FIGURE 5.0 FLIGHT S/W PARAMETERS VS. TRACK CONTROL

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT

Each byte of the programmable parameter set is listed below. Bytes are numbered from 0 to 273, for a total of 274 bytes. The parameter name listed in the table is the name used by the program in referencing the parameter value. Set 1 Value is the value in parameter set 1 for the particular parameter. Parameter set 1 is used by default when the altimeter is powered up.

Byte	Parameter	Set 1 Value	Description
0	Iscan_Min_Hgt	8.4992 mSec	Minimum Interference Scan height, 48 bits, MSB = 6.5536 msec
1			MSByte of LSWord
2			LSByte of Middle Word
3			MSByte of Middle Word
4			LSByte of Upper Word
5			MSByte of Upper Word
6	Iscan_Max_Hgt	9.318 mSec	Max Scan height, 48 bits, MSBit = 6.5536 msec
7			MSByte of LSWord
8			LSByte of Middle Word
9			MSByte of Middle Word
10			LSByte of Upper Word
11			MSByte of Upper Word
12	Iscan_Hgt_Inc	200.0 nSec	Iscan Height Increment 48 bits, MSBit = 6.5536 msec
13			MSByte of LSWord
14			LSByte of Middle Word
15			MSByte of Middle Word
16			LSByte of Upper Word
17			MSByte of Upper Word
18	Cal-I Index 1	77	Cal-I Tracking waveform sample index 1, 8 bits (samples indexed 0..127)
19	Cal-I Index 2	78	Cal-I Tracking waveform sample index 2, 8 bits
20	Cal-I Ku Min AGC Gate	1024	Cal-I Ku Minimum AGC Gate, 16 bits, LSByte
21			Cal-I Ku Minimum AGC Gate, MSByte
22	Cal-I C Min AGC Gate	1024	Cal-I C Minimum AGC Gate, 16 bits, LSByte
23			Cal-I C Minimum AGC Gate, MSByte

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

24	CI_AGC_Threshold	16384	Cal-I AGC Threshold, 16 bits, LSByte
25			Cal-I AGC Threshold, MSByte
26	CI-AGC_Alpha	2	Cal-I AGC Alpha, 8 bits, # of right shifts of AGC Error (power of 2)
27	CI_Track_Alpha	2	Cal-I Track Alpha, 8 bits, # of right shifts
28	CI_Ku_Hgt_Error_Scale	24	Cal-I Ku Height Error Scale, 8 bits, # of left shifts
29	CI_C_Hgt_Error_Scale	24	Cal-I C Height Error Scale, 8 bits, # of left shifts
30	CI_AGC_Error_Scale	35	Cal-I AGC Error Scale, 16 bits, LSByte
31			Cal-I AGC Error Scale, MSByte
32	AGC_Threshold	4096	AGC Threshold, 16 bits, Track modes and Cal-II, LSByte
33			AGC Threshold, MSByte
34	Low_Vres	6	Vres value used in Low Resolution Modes
35	Hgt_Adjustment	0	subtracted from tracker height when changing from Low to High res track, 8 bits, LSBit = 3.125 ns
36	AGC_Adjustment	18 dB	subtracted from Primary and Secondary AGC's when changing from Low to High res track, 32 bits, MSBit = 32dB, LSByte of LSWord
37			MSByte of LSWord
38			LSByte of MSWord
39			MSByte of MSWord
40	AGC_Error_Scale	139	LSByte, 8 bits
41			MSByte
42	Ku_AGC_Gate_Scale	1	8 bits
43	C-100_AGC_Gate_Scale	32	8 bits
44	C_320_AGC_Gate-Scale	4	8 bits
45	LRA_Min_Height	1275 Km	Low res acquisition min height. 48-bits, MSBit = 6.55 msec, LSByte of LSWord
46			MSByte of LSWord
47			LSByte of Middle Word
48			MSByte of Middle Word
49			LSByte of MSWord
50			MSByte of MSWord

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

51	LRA_Max_Height	1398 Km	Low res acquisition max height, 48-bits, MSBit = 6.55 msec, LSByte of LSWord
52			MSByte of LSWord
53			LSByte of Middle Word
54			MSByte of Middle Word
55			LSByte of MSWord
56			MSByte of MSWord
57	LRA_Height_Inc	3.24 Km	Low res acquisition height increment, (scan step size), 48-bits, MSBit = 6.55 msec, LSByte of LSWord
58			MSByte of LSWord
59			LSByte of Middle Word
60			MSByte of Middle Word
61			LSByte of MSWord
62			MSByte of MSWord
63	LRA_AGC_Dec	4.25 dB	Low res acquisition AGC decrement, 32-bits, MSBit = 32 dB, LSByte of LSWord
64			MSByte of LSWord
65			LSByte of MSWord
66			MSByte of MSWord
67	AGC_Minimum	10 dB	Minimum AGC Value, 32-bits, MSBit = 32 dB, LSByte of LSWord
68			MSByte of LSWord
69			LSByte of MSWord
70			MSByte of MSWord
71	Delta_AGC	30 dB	AGC adjustment for entering Low res acquisition, 32-bits, MSBit = 32 dB, LSByte of LSWord
72			MSByte of LSWord
73			LSByte of MSWord
74			MSByte of MSWord
75	HRA_Scan_Window	800.0 nSec	High res acquisition scan window size, 8-bits, LSBit = 100 ns

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

76	HRA_Scan_Hgt_Inc	200.0 nSec	High res acquisition scan height increment, 48-bits, MSBit = 6.55 milliseconds, LSByte of LSWord
77			MSByte of LSWord
78			LSByte of Middle Word
79			MSByte of Middle Word
80			LSByte of MSWord
81			MSByte of MSWord
82	HRA_AGC_NoiseI1	4	High res acquisition AGC noise index 1, 8-bits, (bins start at 0)
83	HRA_AGC_NoiseI2	7	High res acquisition AGC noise index 2, 8-bits
84	HRA_Min_Sig_Thr	256	High res acquisition min signal threshold, 16-bits, bit significance same as waveform samples, LSByte
85			MSByte
86	LR_Ku_NoiseI1	4	Low res Ku noise index 1 (waveform sample index) 8-bits
87	LR_Ku_NoiseI2	7	Low res Ku noise index 2, 8-bits
88	LR_Ku_Thr_Hgt_Scale	31	Low res Ku threshold height scale, 8=bits, # of left shifts of height error
89	HR_Ku_AGC_I1	16	High res Ku AGC index 1, 8-bits, (waveform sample index)
90	HR_Ku_AGC_I2	47	High res Ku AGC index 2, 8-bits, (waveform sample index)
91	HR_Ku_NoiseI1	4	High res Ku noise index 1, 8-bits, (waveform sample index)
92	HR_Ku_NoiseI2	7	High res Ku noise index 2, 8-bits, (waveform sample index)
93	Ku_HR_Thr_Hgt	25	Ku high res threshold height scale, 8-bits, # of left shifts
94	Fine_Trk_Ku_Alpha	2	Fine track Ku alpha, 8-bits, # of right shifts of height error
95	Coarse_Trk_Ku_Alpha	1	Coarse track Ku alpha, 8-bits, # of right shifts of height error
96	Ku_AGC_Scale1	33458	AGC Multiplier for gate index 1, 16-bits, LSByte
97			MSByte
98	Ku_AGC_Scale2	33458	AGC Multiplier for gate index 2, 16-bits, LSByte
99			MSByte
100	Ku_AGC_Scale3	33511	AGC Multiplier for gate index 3, 16-bits, LSByte
101			MSByte
102	Ku-AGC_Scale4	33479	AGC Multiplier for gate index 4, 16-bits, LSByte
103			MSByte

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

104	Ku_AGC_Scale5	33309	AGC Multiplier for gate index 5, 16-bits, LSByte
105			MSByte
106	Ku_AGC_Scale6	32768	AGC Multiplier for gate index 6, 16-bits, LSByte
107			MSByte
108	Ku_EML_Hgt_Scale1	77	Ku EML Height error scale factor, gate index 1, 16-bits
109			
110	Ku_EML_Hgt_Scale2	105	Ku EML Height error scale factor, gate index 2, 16-bits
111			
112	Ku_EML_Hgt_Scale3	262	Ku EML Height error scale factor, gate index 3, 16-bits
113			
114	Ku_EML_Hgt_Scale4	696	Ku EML Height error scale factor, gate index 4, 16-bits
115			
116	Ku_EML_Hgt_Scale5	1882	Ku EML Height error scale factor, gate index 5, 16-bits
117			
118	LR_C_NoiseI1	4	Low res C noise index 1 (waveform sample index) 8-bits
119	LR_C_NoiseI2	7	Low res C noise index 2, 8-bits
120	LR_C_Thr_Hgt_Scale	31	Low res C threshold height scale, 8=bits, # of left shifts of height error
121	HR_C_AGCI1	16	High res C AGC index 1, 8-bits, (waveform sample index)
122	HR_C_AGC_I2	47	High res C AGC index 2, 8-bits, (waveform sample index)
123	HR_C_NoiseI1	4	High res C noise index 1, 8-bits, (waveform sample index)
124	HR_C_NoiseI2	7	High res C noise index 2, 8-bits, (waveform sample index)
125	C_HR_Thr_Hgt	25	C high res threshold height scale, 8-bits, # of left shifts
126	Fine_Trk_C_Alpha	2	Fine track C alpha, 8-bits, # of right shifts of height error
127	Coarse_Trk_C_Alpha	1	Coarse track C alpha, 8-bits, # of right shifts of height error
128	C_AGC_Scale1	32768	AGC Multiplier for gate index 1, 16-bits, LSByte
129			MSByte
130	C_AGC_Scale2	32768	AGC Multiplier for gate index 2, 16-bits, LSByte
131			MSByte
132	C_AGC_Scale3	32809	AGC Multiplier for gate index 3, 16-bits, LSByte

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

133			MSByte
134	C-AGC_Scale4	32839	AGC Multiplier for gate index 4, 16-bits, LSByte
135			MSByte
136	C_AGC_Scale5	32829	AGC Multiplier for gate index 5, 16-bits, LSByte
137			MSByte
138	C_AGC_Scale6	32768	AGC Multiplier for gate index 6, 16-bits, LSByte
139			MSByte
140	C_EML_Hgt_Scale1	312	C EML Height error scale factor, gate index 1, 16-bits
141			
142	C_EML_Hgt_Scale2	440	C EML Height error scale factor, gate index 2, 16-bits
143			
144	C_EML_Hgt_Scale3	1040	C EML Height error scale factor, gate index 3, 16-bits
145			
146	C_EML_Hgt_Scale4	2784	C EML Height error scale factor, gate index 4, 16-bits
147			
148	C_EML_Hgt_Scale5	7112	C EML Height error scale factor, gate index 5, 16-bits
149			
150	LR_Track_Point	63.5	Low res track point, 8-bits, LSBit = 1/2 a waveform sample bin
151	T1	24	"adequate signal width," 16-bits, LSB = 1/2 waveform sample bin, LSByte
152			MSByte
153	T2	160	"adequate signal variability," 16-bits, in 1/2 bins squared, summed for 10 track intervals, LSByte
154			MSByte
155	T3	16	"Good signal width," 16-bits, LSBit = 1/2 a waveform sample bin, LSByte
156			MSByte
157	T4	40	"Good signal variability," 16-bits, in 1/2 bins squared, summed for 10 track intervals, LSByte
158			MSByte
159	T8	1024	"Absolute Threshold," same scaling as waveform samples, LSByte
160			MSByte

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

161	Ku_Early_Index1_1	31	Ku Early index1, gate index 1, waveform bin index, 8-bits
162	Ku_Early_Index2_1	31	Ku Early index2, gate index 1, waveform bin index, 8-bits
163	Ku_Early_Index1_2	30	Ku Early index1, gate index 2, waveform bin index, 8-bits
164	Ku_Early_Index2_2	31	Ku Early index2, gate index 2, waveform bin index, 8-bits
165	Ku_Early_Index1_3	29	Ku Early index1, gate index 3, waveform bin index, 8-bits
166	Ku_Early_Index2_3	30	Ku Early index2, gate index 3, waveform bin index, 8-bits
167	Ku_Early_Index1_4	26	Ku Early index1, gate index 4, waveform bin index, 8-bits
168	Ku_Early_Index2_4	29	Ku Early index2, gate index 4, waveform bin index, 8-bits
169	Ku_Early_Index1_5	20	Ku Early index1, gate index 5, waveform bin index, 8-bits
170	Ku_Early_Index2_5	27	Ku Early index2, gate index 5, waveform bin index, 8-bits
171	Ku_Early_Index1_6	8	Ku Early index1, gate index 6, waveform bin index, 8-bits
172	Ku_Early_Index2_6	23	Ku Early index2, gate index 6, waveform bin index, 8-bits
173	Ku_Middle_Index1_1	31	Ku Middle index1, gate index 1, waveform bin index, 8-bits
174	Ku_Middle_Index2_1	32	Ku Middle index2, gate index 1, waveform bin index, 8-bits
175	Ku_Middle_Index1_2	31	Ku Middle index1, gate index 2, waveform bin index, 8-bits
176	Ku_Middle_Index2_2	32	Ku Middle index2, gate index 2, waveform bin index, 8-bits
177	Ku_Middle_Index1_3	30	Ku Middle index1, gate index 3, waveform bin index, 8-bits
178	Ku_Middle_Index2_3	33	Ku Middle index2, gate index 3, waveform bin index, 8-bits
179	Ku_Middle_Index1_4	28	Ku Middle index1, gate index 4, waveform bin index, 8-bits
180	Ku_Middle_Index2_4	35	Ku Middle index2, gate index 4, waveform bin index, 8-bits
181	Ku_Middle_Index1_5	24	Ku Middle index1, gate index 5, waveform bin index, 8-bits
182	Ku_Middle_Index2_5	39	Ku Middle index2, gate index 5, waveform bin index, 8-bits
183	Ku_Middle_Index1_6	24	Ku Middle index1, gate index 6, waveform bin index, 8-bits
184	Ku_Middle_Index2_6	39	Ku Middle index2, gate index 6, waveform bin index, 8-bits
185	Ku_Late_Index1_1	32	Ku Late index1, gate index 1, waveform bin index, 8-bits
186	Ku_Late_Index2_1	32	Ku Late index2, gate index 1, waveform bin index, 8-bits
187	Ku_Late_Index1_2	32	Ku Late index1, gate index 2, waveform bin index, 8-bits
188	Ku_Late_Index2_2	33	Ku Late index2, gate index 2, waveform bin index, 8-bits
189	Ku_Late_Index1_3	33	Ku Late index1, gate index 3, waveform bin index, 8-bits

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

190	Ku_Late_Index2_3	34	Ku Late index2, gate index 3, waveform bin index, 8-bits
191	Ku_Late_Index1_4	34	Ku Late index1, gate index 4, waveform bin index, 8-bits
192	Ku_Late_Index2_4	37	Ku Late index2, gate index 4, waveform bin index, 8-bits
193	Ku_Late_Index1_5	36	Ku Late index1, gate index 5, waveform bin index, 8-bits
194	Ku_Late_Index2_5	43	Ku Late index2, gate index 5, waveform bin index, 8-bits
195	Ku_Late_Index1_6	40	Ku Late index1, gate index 6, waveform bin index, 8-bits
196	Ku_Late_Index2_6	55	Ku Late index2, gate index 6, waveform bin index, 8-bits
197	C_Early_Index1_1	31	C Early index1, gate index 1, waveform bin index, 8-bits
198	C_Early_Index2_1	31	C Early index2, gate index 1, waveform bin index, 8-bits
199	C_Early_Index1_2	30	C Early index1, gate index 2, waveform bin index, 8-bits
200	C_Early_Index2_2	31	C Early index2, gate index 2, waveform bin index, 8-bits
201	C_Early_Index1_3	29	C Early index1, gate index 3, waveform bin index, 8-bits
202	C_Early_Index2_3	30	C Early index2, gate index 3, waveform bin index, 8-bits
203	C_Early_Index1_4	26	C Early index1, gate index 4, waveform bin index, 8-bits
204	C_Early_Index2_4	29	C Early index2, gate index 4, waveform bin index, 8-bits
205	C_Early_Index1_5	20	C Early index1, gate index 5, waveform bin index, 8-bits
206	C_Early_Index2_5	27	C Early index2, gate index 5, waveform bin index, 8-bits
207	C_Early_Index1_6	8	C Early index1, gate index 6, waveform bin index, 8-bits
208	C_Early_Index2_6	23	C Early index2, gate index 6, waveform bin index, 8-bits
209	C_Middle_Index1_1	31	C Middle Index1, gate index 1, waveform bin index, 8-bits
210	C_Middle_Index2_1	32	C Middle Index2, gate index 1, waveform bin index, 8-bits
211	C_Middle_Index1_2	31	C Middle Index1, gate index 2, waveform bin index, 8-bits
212	C_Middle_Index2_2	32	C Middle Index2, gate index 2, waveform bin index, 8-bits
213	C_Middle_Index1_3	30	C Middle Index1, gate index 3, waveform bin index, 8-bits
214	C_Middle_Index2_3	33	C Middle Index2, gate index 3, waveform bin index, 8-bits
215	C_Middle_Index1_4	28	C Middle Index1, gate index 4, waveform bin index, 8-bits
216	C_Middle_Index2_4	35	C Middle Index2, gate index 4, waveform bin index, 8-bits
217	C_Middle_Index1_5	24	C Middle Index1, gate index 5, waveform bin index, 8-bits
218	C_Middle_Index2_5	39	C Middle Index2, gate index 5, waveform bin index, 8-bits

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

219	C_Middle_Index1_6	24	C Middle Index1, gate index 6, waveform bin index, 8-bits
220	C_Middle_Index2_6	39	C Middle Index2, gate index 6, waveform bin index, 8-bits
221	C_Late_Index1_1	32	C Late Index1, gate index 1, waveform bin index, 8-bits
222	C_Late_Index2_1	32	C Late Index2, gate index 1, waveform bin index, 8-bits
223	C_Late_Index1_2	32	C Late Index1, gate index 2, waveform bin index, 8-bits
224	C_Late_Index2_2	33	C Late Index2, gate index 2, waveform bin index, 8-bits
225	C_Late_Index1_3	33	C Late Index1, gate index 3, waveform bin index, 8-bits
226	C_Late_Index2_3	34	C Late Index2, gate index 3, waveform bin index, 8-bits
227	C_Late_Index1_4	34	C Late Index1, gate index 4, waveform bin index, 8-bits
228	C_Late_Index2_4	37	C Late Index2, gate index 4, waveform bin index, 8-bits
229	C_Late_Index1_5	36	C Late Index1, gate index 5, waveform bin index, 8-bits
230	C_Late_Index2_5	43	C Late Index2, gate index 5, waveform bin index, 8-bits
231	C_Late_Index1_6	40	C Late Index1, gate index 6, waveform bin index, 8-bits
232	C_Late_Index2_6	55	C Late Index2, gate index 6, waveform bin index, 8-bits
233	RAVE Time Constant	8	Late-Early running average time constant, 16-bits, LSbit = 1/128, LSByte
234			MSByte
235	Ku_GI_Scale	82	Ku Gate Index Scale factor, 8-bits, program multiplieas this value by 2**7
236	C_320_GI_Scale	78	C 320 Gate Index Scale factor, 8-bits, program multiplies this value by 2**7
237	C_100_GI_Scale	70	C 100 Gate Index Scale factor, 8-bits, program multiplies this value by 2**7
238	HR_Track_Point	63	High res Track Point, 8-bits, LSBit = 1/2 waveform sample bin
239	Thr_Hgt_Err_Win1	8	Threshold Height Error Window, gate index 1, 8-bits
240	Thr_Hgt_Err_Win2	8	Threshold Height Error Window, gate index 2, 8-bits
241	Thr_Hgt_Err_Win3	12	Threshold Height Error Window, gate index 3, 8-bits
242	Thr_Hgt_Err_Win4	16	Threshold Height Error Window, gate index 4, 8-bits
243	Thr_Hgt_Err_Win5	32	Threshold Height Error Window, gate index 5, 8-bits
244	Fine_Trk_AGC_Alpha	3	Fine Track AGC Alpha, 8-bits, # of right shifts of AGC error
245	Fine_Track_Beta	6	Fine Track Beta, 8-bits, # of right shifts of Height rate
246	Coarse_Trk_AGC_Alpha	2	Coarse Track AGC Alpha, 8-bits, # of right shifts of AGC error
247	Coarse_Track_Beta	4	Coarse Track Beta, 8-bits, # of right shifts of height rate

TABLE 5.0
PROGRAMMABLE PARAMETER DESCRIPTION AND UPLOAD FORMAT
(continued)

248	T5	2560	variability threshold, 16-bits, units are 1/2 bins squared * 10, thus 8-bins RMS => 2560 = T5, LSByte
249			MSByte
250	T6	10240	"poor variability," 16-bits, units are 1/2 bins squared * 10, LSByte
251			MSByte
252	T7	256	"absolute threshold," 16-bits, units of waveform samples, LSByte
253			MSByte
254	Ku_Pulse_Count	25	Ku Pulse Count, 8-bits
255	C_Pulse_Count	26	C Pulse Count, 8-bits
256	Acq_Pulse_Count	26	Acquisition pulse count, 8-bits, (Low res acquisition)
257	AGC_Rate	13	AGC Rate, 16-bits, LSByte
258			MSByte
259	Xmit_Test_Height	8609.6 µSec	Transmit Test Height, 48-bits, MSBit = 6.55 msec. LSByte of LSWord
260			MSByte of LSWord
261			LSByte of Middle Word
262			MSByte of Middle Word
263			LSByte of Upper Word
264			MSByte of Upper Word
265	Xmit_Test_Hgt_Rate	0	Transmit Test Height Rate, 48-bits, LSBit = 130.897e-9 meters/seconds
266			MSByte of LSWord
267			LSByte of Middle Word
268			MSByte of Middle Word
269			LSByte of Upper Word
270			MSByte of Upper Word
271	Xmit_Test_AGC	42 dB	Transmit Test AGC, 8-bits, MSBit = 32 dB
272	BC_Init	0	Initial Burst_Count Value (for changing number of bursts per track interval)
273	WD_Init	25	Initial Watchdog timer count (same as above)

5.8 Height and AGC Adjustments

The tracker height and AGC will be increased by these adjustments on transition from high to low resolution. They will be decreased by these adjustments on transition from low to high resolution.

5.9 AGC Error Scale

In track mode, the AGC error scale changes a 1-bit AGC error into the scaling used by the AGC tracking loop and the synchronizer.

5.10 AGC Gate Scales

The same AGC Threshold is used for both the C and Ku channels; however, one-fourth as many C waveforms are summed each track interval as are Ku waveforms. Thus, the AGC gate (formed from an average of waveform samples) must be scaled, depending on the channel, before subtracting the AGC Threshold to form an error signal. The Ku AGC Gate Scale is 1, while the C AGC Gate Scale is 4, to compensate for the difference in the number of summed waveforms.

5.11 Coarse Acquisition Parameters

At the start of Coarse (low resolution) Acquisition, the height will be set to the Coarse Acq Minimum Scan Height. Each track interval, it will increment by the Coarse Acq Scan Height Increment, until the Coarse Acq Maximum Scan Height is reached or exceeded (i.e., the scan increments do not have to cover the minimum to maximum range exactly). To prevent the signal from "falling through a crack," the scan height increment should be less than the height range covered by one waveform at the current coarse-resolution setting. The waveform size can be calculated as follows:

$$\text{Waveform (ns)} = \text{Coarse Resolution (ns)} * 128$$

An overlap of at least 8 waveform samples is recommended; thus the maximum scan height increment should be:

$$\begin{aligned}\text{Scan Height Increment (ns)} &= \text{Waveform (ns)} - \text{Coarse Resolution (ns)} * 8 \\ &= \text{Coarse Resolution (ns)} * 120\end{aligned}$$

A further constraint is placed on the scan height increment by the flight software design. For proper operation of the flight software, the number of steps required to cover the entire interval (maximum height - minimum height) should be equal to:

$$10*N + 8,\ N = 0, 1, 2....$$

When Coarse Acquisition is initialized, the primary channel AGC is set to the noise level calculated during the last Cal-II, plus the AGC Delta parameter. If the entire acquisition range is searched without finding the signal, then the AGC is lowered by the Coarse Acq AGC Decrement, and the range is scanned again. This sequence is repeated until the signal is found, or the AGC is decremented to the AGC Minimum. Then the scan is repeated at the AGC Minimum until the signal is found. The switch from coarse resolution is on the half-frame boundary.

5.12 Fine-Acquisition Parameters

When fine (high resolution) acquisition is initiated, the height and AGC are both adjusted to account for the resolution change. During fine acquisition, the height is scanned in a window around this initial height. One-half the Fine Acq Scan Window is subtracted from the height. Each track interval, the height will be incremented by the Fine Acq Scan Height Increment until the signal is found, or the height becomes greater than the initial height plus one-half the Fine Acq Scan Window. To prevent the signal from "falling in a crack," the Fine Acq Scan Height Increment should be less than the total height range covered by one waveform at high resolution. The overlap should be at least 8 range bins, so the maximum increment should be: 120 bins * 3.125 ns = 375 ns.

During fine acquisition, the maximum waveform sample on the primary channel is compared to the Fine Acq Minimum Signal Threshold. If it exceeds the threshold, and is greater than twice the noise estimate, it is considered to be the signal.

5.13 Noise Indices

A noise estimate is formed by averaging the waveform samples from Noise Index1 to Noise Index2 (zero origin indexing). The noise indices used for the Fine Acquisition, Coarse Tracking, and Fine Tracking are separately programmable. For coarse-and fine-resolution tracking, the noise indices used on the Ku and C channels are also separately programmable.

5.14 Coarse-Track Threshold Height Scale

The coarse-threshold height scale factors change the height error from units of "waveform sample number" to the units of the 48-bit tracker height. These height scales are a function of Coarse Resolution and Coarse-Track Point (see paragraphs 5.15 and 5.30), and may be computed:

Coarse-Track Threshold Height Scale =
Coarse Resolution(ns) * LSB(Coarse-Track Track Point)/4.6566E-8 ns

There is one programmable height scale for Ku and one for C.

5.15 Fine-Track AGC Indices

As part of forming the AGC gates for fine tracking and for Cal-II mode, the waveform samples from Fine Track AGC Index1 and Fine Track AGC Index2 (inclusive) are averaged. There are separately programmable indices for Ku and for C.

5.16 AGC Scale Factors

These scale factors adjust the AGC gate calculation for differences in gate index. There are six separately programmable scale factors (one for each gate index) for the Ku channel, and six others for the C channel.

6.0 MOS DISPLAY REQUIREMENTS

6.1 General Requirements

It is required for selected passes that the TOPEX NASA radar altimeter (NRA) data be displayed in realtime at the MOS for engineering evaluation, and that realtime commanding be available. Specific requirements are:

a) All data shall be accessible and displayed in engineering units.

b) A hardcopy may be made of any display.

c) Data displays are to be capable of being frozen and unfrozen.

d) For all passes for which playback data is received, the playback data will be displayed in quasi-realtime (approximately 10 minutes from receipt of first data), the same as for the realtime.

e) All received data will be processed for alarm limits, and alarms displayed within 20 minutes of data receipt.

f) If certain alarms are displayed, immediate action will be taken to schedule a realtime command uplink pass if the current pass is not an uplink pass or insufficient time remains to safeguard the altimeter. Updates to the alarm limits will be supported.

g) It will be possible to produce a channelized hardcopy of selected parameters in engineering units.

h) It will be possible to select any parameter for plot display. This screen display would look similar to a strip chart.

6.2 Data Display Requirements

The data display requirements for the MOS consist of a set of predefined screen layouts that will show all altimeter data or s/c-related data. The screens will display engineering data, science data, s/c-related data, alarms and status. All displays will contain NRA status, s/c status, command and time information. Any displayed parameter can be flagged at two levels: one for warning and one for danger. It shall be possible to display up to 6 screens at one time and some of these screens may be the same display. It shall be possible to interactively change the selected display on any screen. The following are preliminary screen definitions.

Display	Description
1	Standard 1 (Mixed)
2	Standard 2 (Mixed)
3	Temperature display 1
4	Temperature display 2 (includes s/c data)
5	Voltage, current from altimeter and s/c
6	Surface measurement data
7	Ku waveforms

8 C waveforms
9 Alarm display
10 Status display
11 Memory load
12 Memory dump

6.3 Parameters to be Monitored

6.3.1 Required in MOS

NRA Engineering Telemetry
- All 50 Engineering words
- All command Echo
- Time
- Status bytes
- Last reset time
- Memory dump

S/C Telemetry
- NRA Thermistor Data (8 words)
- NRA Telltales (18 bits)
- NRA Voltage
- NRA current

Science Telemetry

6.3.2 Desired in MOS

Engineering Telemetry
- Spares

S/C Telemetry
- Attitude Estimate

Science Telemetry
- Time
- Calibrate attenuators
- Mode Block
- Status block
- Ku Height
- C height
- Height rate
- Ku AGC
- C AGC
- Ku SWH
- C SWH
- Waveform Samples

7.0 TELEMETRY

7.1 Science Telemetry

The TOPEX telemetered science frame consists of 1228 bytes, incorporating science data, command echoing, and altimeter operating status. The science frame telemetry and associated engineering unit conversions are listed in Table 7.1.

7.2 Engineering Telemetry

The TOPEX telemetered engineering frame consists of 128 bytes which are described in Table 7.2, along with the associated coefficients to convert the counts to engineering units. Values in columns A through F in Table 7.2 are the polynomial coefficients used to convert the counts for that particular parameter to engineering units. The polynomial for the conversion is $y = A + Bx + Cx^2 + Dx^3 + Ex^4 + Fx^5$, where x equals the raw count value and y is the converted measurement in the appropriate units. For conversions where a lower order polynomial is sufficient, the later coefficients are set equal to zero.

TABLE 7.1
(Preliminary)
TOPEX ALTIMETER SCIENCE FRAME

Byte Count	# Bytes	Contents	Conversion
0	1	Sync code - byte 1 - 1A hex	Concatenate six bytes - No conversion
1	1	Sync code - byte 2 - CF hex	(1ACFFC1DBADD hex)
2	1	Sync code - byte 3 - FC hex	
3	1	Sync code - byte 4 - 1D hex	
4	1	Sync code - byte 5 - BA hex	
5	1	Sync code - byte 6 - DD hex	
6	1	Primary calibrate attenuator	No Conversion - See Note A
7	1	Secondary calibrate attenuator	No Conversion - See Note A
8	1	Current Mode	No Conversion - See Note B
9	1	Mode Change Type	No Conversion - See Note C
10-96	87	Data Block A	Refer to Block A Description
97	1	Gate Index	No Conversion - See Note D
98-249	152	Data Block B	Refer to Block B Description
250-336	87	Data Block A	Refer to Block A Description
337	1	Test Mode Byte	No Conversion - See Note E
338-489	152	Data Block B	Refer to Block B Description
490-576	87	Data Block A	Refer to Block A Description
577	1	Limit Byte	No Conversion - See Note F
578	1	Synchronizer Mode Bits - byte 1 (LSB)	Concatenate two bytes - See Note G
579	1	Synchronizer Mode Bits - byte 2 (MSB)	
580	1	Operation Mode Byte	No Conversion - See Note H
581	1	Spare	No Conversion

TABLE 7.1 (Continued)
(Preliminary)
TOPEX ALTIMETER SCIENCE FRAME

Byte Count	# Bytes	Contents	Conversion
582	1	Current Mode	No Conversion - See Note B
583	1	Mode Change Type	No Conversion - See Note C
584-735	152	Data Block B	Refer to Block B Description
736-822	87	Data Block A	Refer to Block A Description
823	1	Spare	No Conversion
824-975	152	Data Block B	Refer to Block B Description
976-1062	87	Data Block A	Refer to Block A Description
1063	1	Spare	No Conversion
1064	1	Last ATA Command Executed - byte 1 (LSB)	Concatenate two bytes - No conversion
1065	1	Last ATA Command Executed - byte 2 (MSB)	(see Note 1 of Engineering Frame)
1066	1	Last ICA Command Executed - byte 1 (LSB)	Concatenate two bytes - No conversion
1067	1	Last ICA Command Executed - byte 2 (MSB)	(see Note 1 of Engineering Frame)
1068-1219	152	Data Block B	Refer to Block B Description
1220	1	Spacecraft time - byte 1 (LSB)	Concatenate six bytes -
1221	1	Spacecraft time - byte 2	
1222	1	Spacecraft time - byte 3	Then multiply by 0.9765625E-6, yielding cumulative spacecraft clock time in seconds
1223	1	Spacecraft time - byte 4	
1224	1	Spacecraft time - byte 5	(Suggest it be converted to a year, day, seconds output)
1225	1	Spacecraft time - byte 6 (MSB)	

TABLE 7.1 (Continued)
(Preliminary)
TOPEX ALTIMETER SCIENCE FRAME

Byte Count	# Bytes	Contents	Conversion
1226	1	Frame Checksum - byte 1 (LSB)	Concatenate two bytes - No conversion
1227	1	Frame Checksum - byte 2 (MSB)	

TABLE 7.1 (Continued)
TOPEX ALTIMETER SCIENCE FRAME
(Preliminary)
DATA BLOCK A

Recurring Byte Count	#Bytes	Contents	Conversion
10-11,98-99,250-251,338-339,490-491,584-585,736-737,824-825,976-977,1068-1069 12-13,100-101,252-253,340-341,492-493,586-587,738-739,826-827,978-979,1070-1071	2 2	Coarse Height 1 (mm) Primary Fine Height 1 (mm)	Concatenate Coarse Height and Primary Fine Height. Then multiply by 3.814697265E-4 ns/count to obtain primary height. Next, add a constant offset (e.g., 8.192E+6 ns) determined during system testing, different for each frequency to yield height in ns. Last, multiply by c/2 (c=speed of light in mm/ns).
14-15,102-103,254-255,342-343,494-495,588-589,740-741,828-829,980-981,1072-1073	2	Height Rate 1 (mm/s)	Multiply by 5.54935E-2 to obtain nanoseconds per second. Then, multiply by c/2 (c=speed of light in mm/ns).
16-17,104-105,256-257,344-345,496-497,590-591,742-743,830-831,982-983,1074-1075	2	Secondary Height Difference 1 (mm)	This is a signed 2's complement value. Algebraically add Secondary Height Difference (in counts) to the raw concatenated Height above, and multiply by 3.814697E-4 ns/count to obtain Secondary Height. Next, add a constant offset (e.g., 4.096E-6ns) determined during system testing, different for each frequency. Last, multiply by c/2 (c=speed of light in mm/ns).
18,106,258,346,498,592,744,832,984,1076	1	Primary AGC 1 (dB)	Multiply by 0.25 dB/count - Then correct for temperature effects via quadratic equations.
19,107,259,347,499,593,745,833,985,1077	1	Secondary AGC 1 (dB)	Multiply by 0.25dB/count - Then correct for temperature effects via quadratic equations.

TABLE 7.1 (Continued)
TOPEX ALTIMETER SCIENCE FRAME
(Preliminary)
DATA BLOCK A

Recurring Byte Count	#Bytes	Contents	Conversion
20-21,108-109,260-261,348-349,500-501,594-595,746-747,834-835,986-987,1078-1079	2	Coarse Height 2 (mm)	See byte 10 above.
22-23,110-111,262-263,350-351,502-503,596-597,748-749,836-837,988-989,1080-1081	2	Primary Fine Height 2 (mm)	
24-25,112-113,264-265,352-353,504-505,598-599,750-751,838-839,990-991,1082-1083	2	Height Rate 2 (mm/s)	See byte 14 above.
26-27,114-115,266-267,354-355,506-507,600-601,752-753,840-841,992-993,1084-1085	2	Secondary Height Difference 2 (mm)	See byte 16 above.
28,116,268,356,508,602,754,842,994,1086	1	Primary AGC 2 (dB)	See byte 18 above.
29,117,269,357,509,603,755,843,995,1087	1	Secondary AGC 2 (dB)	See byte 19 above.
30,118,270,358,510,604,756,844,996,1088	1	Primary SWH (m)	Telemetry stream provides V_{SWH}. SWH = $0.078125 \cdot 10^{Y}$, where $Y = a + bV_{SWH} + c(V_{SWH})^2 + d(V_{SWH})^3$; coefficients will be from table look-up. There will be one table for each combination of gate index (1-5) and bandwidth (Ku/C).

TABLE 7.1 (Continued)
TOPEX ALTIMETER SCIENCE FRAME
(Preliminary)
DATA BLOCK A

Recurring Byte Count	#Bytes	Contents	Conversion
31,119,271,359,511, 605,757,845,997,1089	1	Secondary SWH (m)	Telemetry stream provides V_{SWH}. SWH = $0.078125*10^{Y}$, where $Y=a+bV_{SWH}+c(V_{SWH})^{2}+d(V_{SWH})^{3}$; coefficients will be from table look-up. There will be one table for each combination of gate index (1-5) and bandwidth (Ku/C).
32-95,120-183,272-335,360-423,512-575,606-669,758-821,846-909,998-1061, 1090-1153	64	High Rate Waveform Samples 1-64 (Counts)	No conversion - usage requires scaling by factor determined from table look-up based on decode of the following byte. See Note I.
96,184,336,424,576, 670,822,910,1062,1154	1	High Rate Waveform Scaling/Mode bits	No Conversion - See Note J.

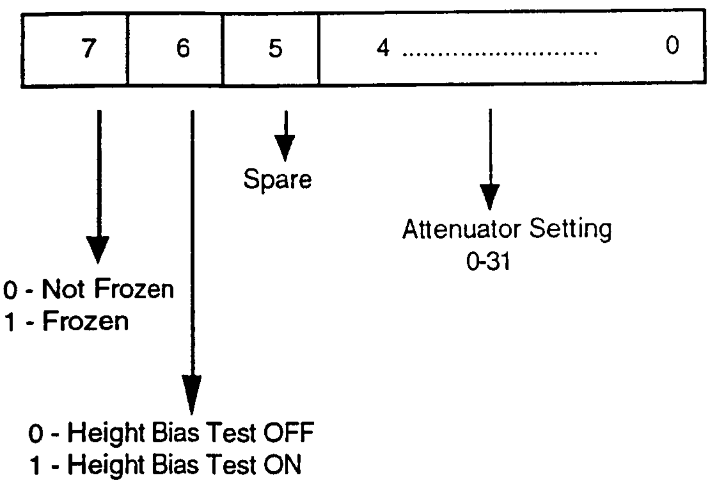
TABLE 7.1 (Continued)
TOPEX ALTIMETER SCIENCE FRAME
(Preliminary)
DATA BLOCK B

Recurring Byte Count	#Bytes	Contents	Conversion
98-184,338-424,584-670,824-910,1068-1154	87	Data Block A	Refer to Block A Description
185,425,671,911,1155	1	Low Rate Waveform Scaling/Mode bits	No Conversion - See Note J.
186-249,426-489,672-735,912-975,1156-1219	64	Low Rate Waveform Samples 1-64 (Counts)	No conversion - usage requires scaling by factor determined from table look-up based on decode of the preceding byte. See Note I.

Note A

The attenuator setting will be used as an index in the calibration-mode processor where it will be converted to the proper temperature corrected setting.

Calibrate Attenuator Setting Bytes



Note B

The individual status indicators are needed to control data processing and data quality in the TOPEX SDS algorithms. This appears twice per frame.

Current Mode Byte

7	6	5	4	3 0

0 - EML Track (changes per 1/2 frame)
1 - Threshold Track (changes per 1/2 frame)

0 - AGC Gate (changes per 1/2 frame)
1 - PrimaryMax/3 (changes per 1/2 frame)

High Variability Flag
0 - False
1 - True: RMS height error>T5
(a programmable threshold)

Note: High Variability forces the use of threshold height errors during fine track

Mode:
0011 - Standby (changes per frame)
0110 - Cal-I (changes per frame)
1100 - Cal-II (changes per frame)
1001 - Coarse Acq.(changes per 1/2 frame)
1010 - Coarse Track (changes per 1/2 frame)
0101 - Fine Acq.(changes per 1/2 frame)
1111 - Fine Track (changes per 1/2 frame)

High/Low Rate
Waveform Channel
Assignment
0 - Ku/C (changes per frame)
1 - C/Ku (changes per frame

TOPEX ALTIMETER
SCIENCE FRAME NOTES (Continued)

Note C

This byte is used for engineering analysis. This appears twice per frame.

Mode Change Byte

0 - FALSE
1 - TRUE

7	6	5	4	3	2	1	0

0: Primary Max Signal < 2 * Noise (lost Fine Track)
1: Primary Max Signal < Min Threshold (Track Lost) - T7 (Coarse) T8 (Fine)
2: Variability > Fine Track Threshold (Fine Track) - T6
3: RMS Delta H < Good Track Threshold (Fine Track) - T4
4: RMS Delta H < Adequate Track Threshold (go Coarse to Fine Track) - T2
5: Signal Width < Good Width (Coarse Track only) - T3
6: Signal Width < Adequate Width (Coarse Track only) - T1
7: Spare

(All of the above change per 1/2 frame)

Note D

The gate indexes are used in the TOPEX SDS algorithms to select the proper coefficients for data correction.

Gate Index Byte

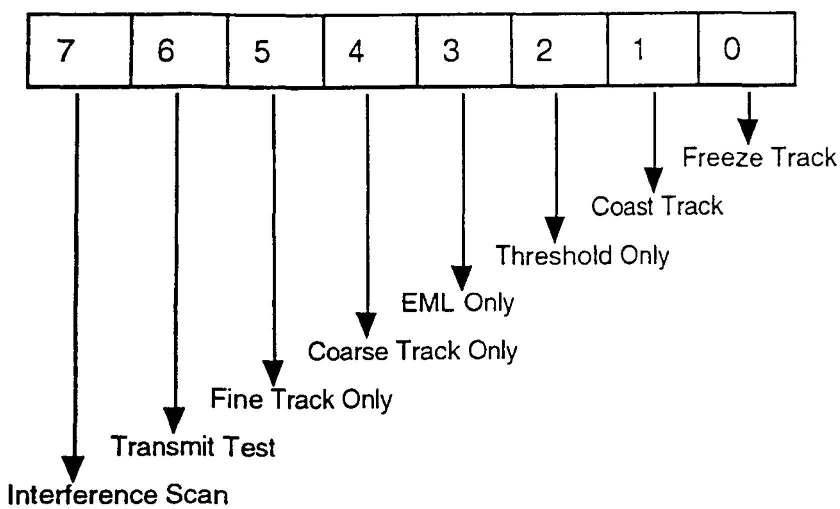
7 4	3 0
Secondary Channel Gate Index (1-5)	Primary Channel Gate Index (1-5)

Note E

The status bits are used in engineering analysis. For normal TOPEX operations, the byte will be all ones.

Test Mode Byte

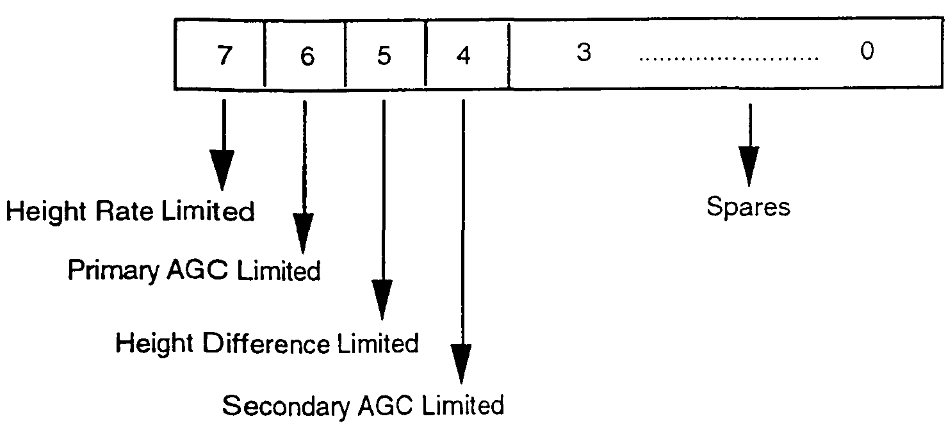
0 - OFF
1- ON



Note F

The status bits are used for data quality in the TOPEX SDS.

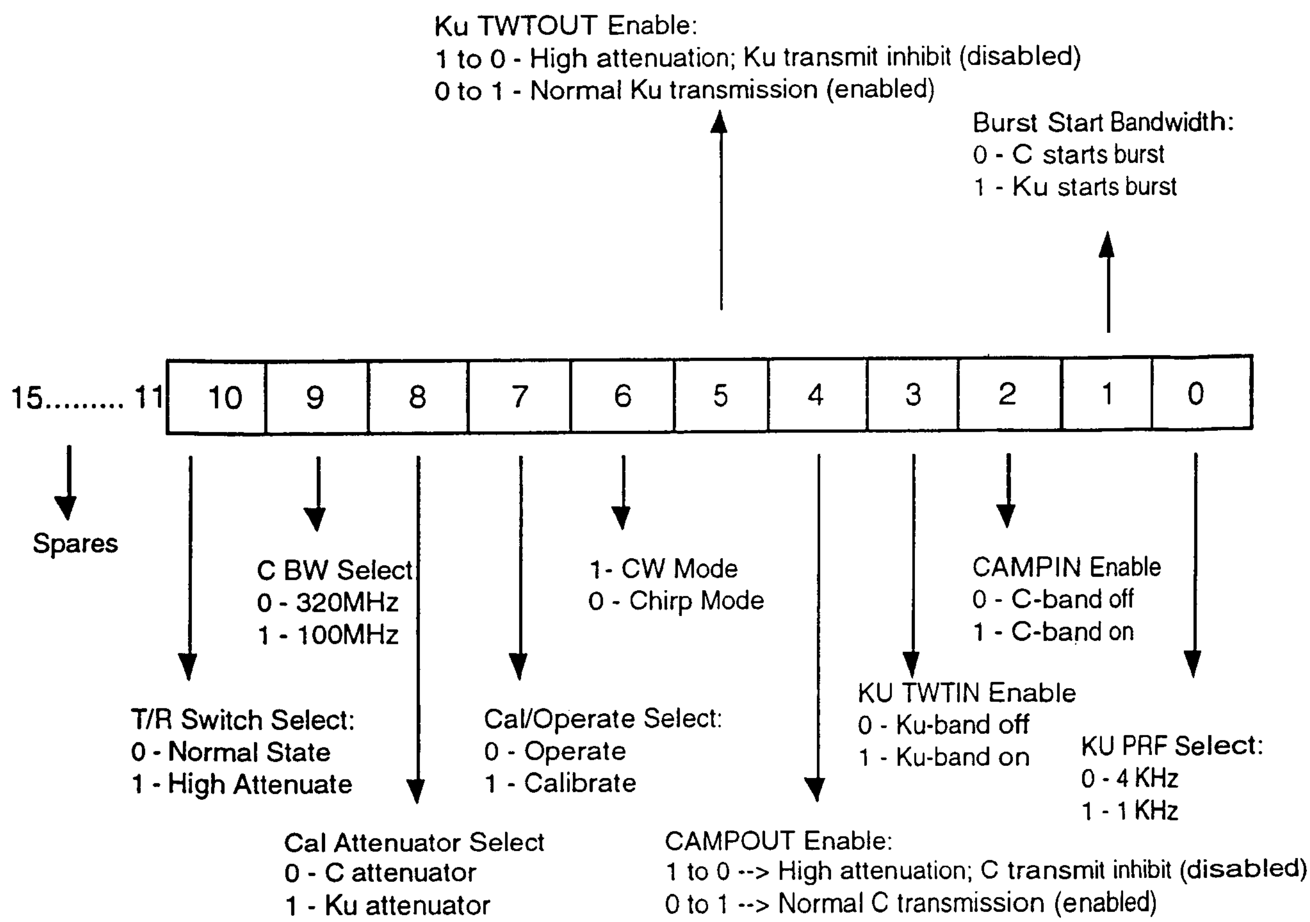
Limit Byte



Note G

These bits are used for engineering analyses and are not used in the normal TOPEX SDS processing.

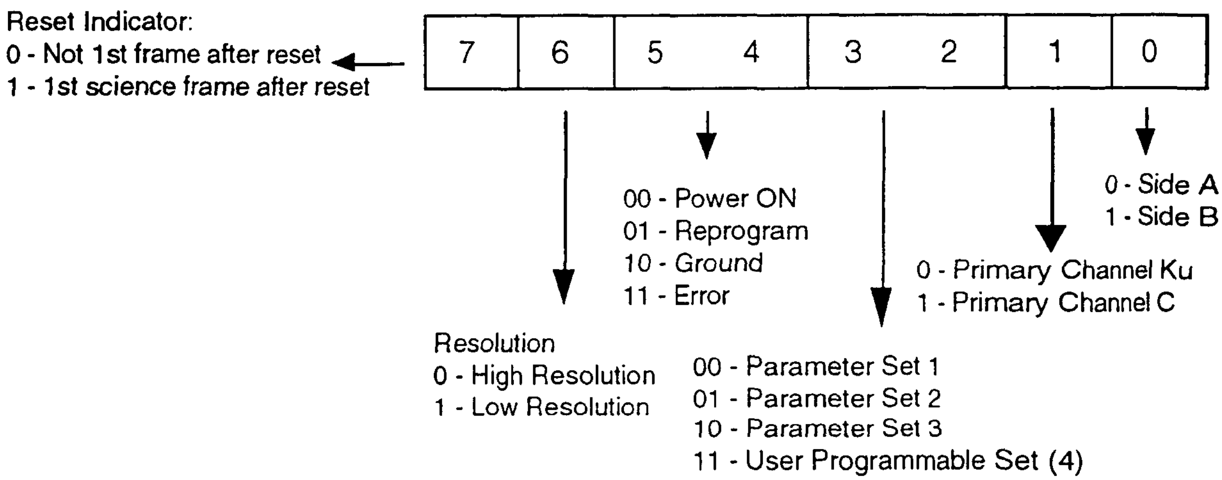
Synchronizer Mode Bits



Note H

The primary channel bit is needed in the TOPEX SDS to control data flow.

Operation Mode Byte



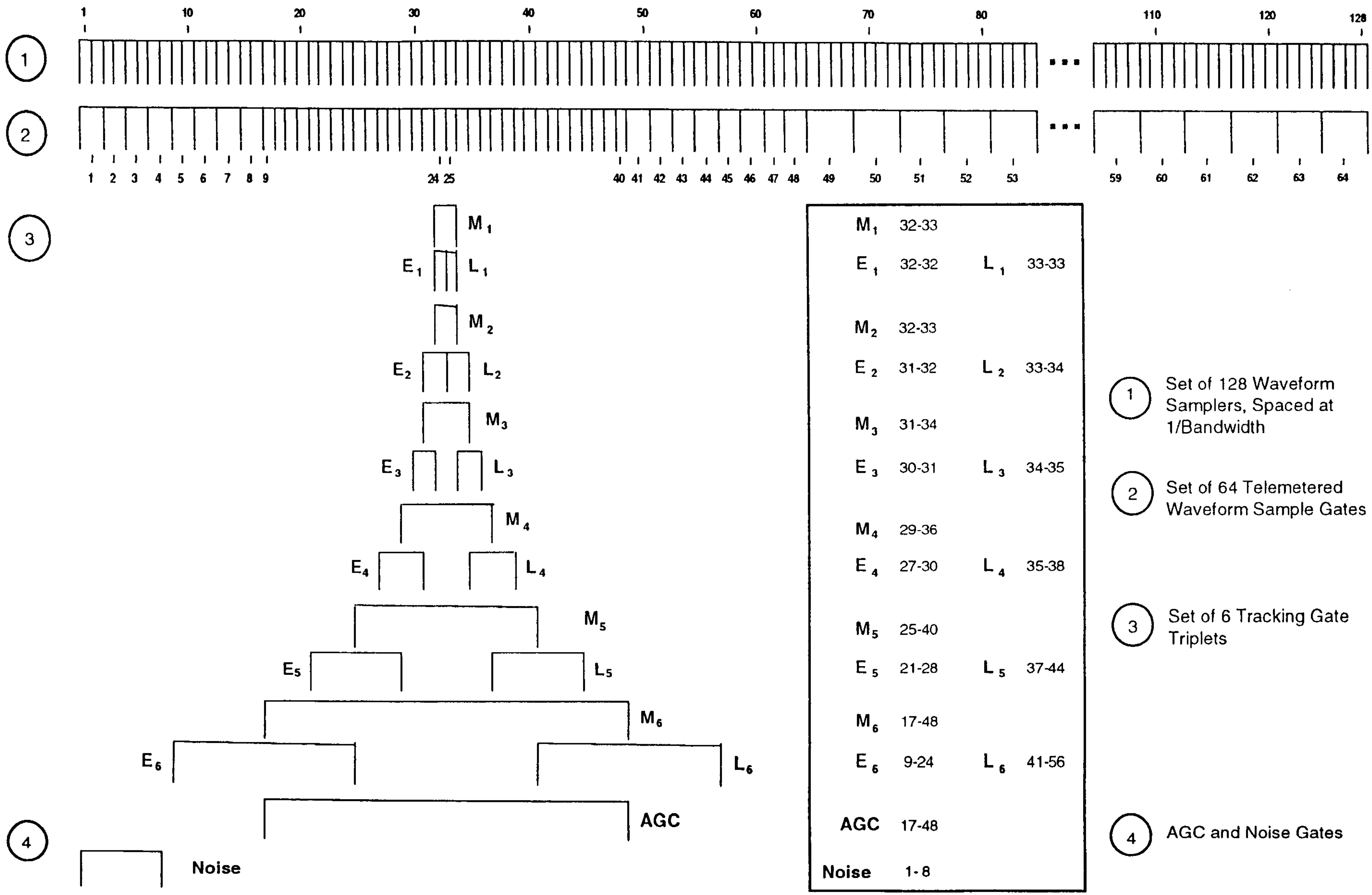
Note I

The TOPEX waveform which is telemetered for ground processing consists of 64 samples which are not all uniformly spaced. The telemetered waveform is formed onboard the spacecraft from 128 uniformly spaced (3.125-nsec separation) tracker waveform samples.

Current Mode	Compression Scheme
Standby Cal-I	Middle 64 samples are used, first 32 samples and last 32 samples are discarded
Coarse Acquisition Coarse Track Fine Acquisition	Adjacent pairs of waveform samples are averaged, i.e., 1-2, 3-4, etc.
Fine Res Track Cal-II	Telemetered samples 1-8 = averages of adjacent pairs of samples 1-16 Telemetered samples 9-40 = waveform samples 17-48 Telemetered samples 41-48 = averages of adjacent pairs of samples 49-64 Telemetered samples 49-64 = averages of groups of 4 waveform samples for samples 65-128, i.e., telemetered sample 49 = average of samples 65-68.

The Figure on the following page depicts, for high-resolution (fine-track) tracking, the TOPEX relationships between: 1) the set of 128 individual onboard altimeter waveform samples; 2) the set of 64 waveform telemetry gates, composed of averages of 1, 2, or 4 of the individual waveform samples; 3) the six different early (E), middle (M), and late (L) gates used in the EML tracking and SWH estimation; and 4) the noise and AGC gates.

Relationships of Onboard Waveform Samplers and Telemetered Tracking Gates



Note J

It is suggested that waveforms not be scaled for the TOPEX standard data product but that the individual data user perform the scaling.

Waveform Mode/Scaling Byte

7	6 4	3 0

Frequency I.D.

High-Rate Waveforms:
0 - Ku Waveform
1 - C Waveform

Low-Rate Waveforms:
0 = C Waveform
1 = Ku Waveform

Spare

Scale Factor

Index	Multiplier
0	32768/214
1	32768/303
2	32768/428
3	32768/605
4	32768/856
5	32768/1211
6	32768/1713
7	32768/2423
8	32768/3427
9	32768/4846
10	32768/6853
11	32768/9692
12	32768/13707
13	32768/19384
14	32768/27413
15	32768/38768

TABLE 7.2

TOPEX ALTIMETER ENGINEERING FRAME

Minor Frame	Data	Minor Frame	Data	Minor Frame	Data	Minor Frame	Data
1	Sync	33	Eng-3	65	Eng-21	97	Eng-39
2	CMD-1	34	CMD-1	66	CMD-1	98	CMD-1
3	CMD-2	35	CMD-2	67	CMD-2	99	CMD-2
4	CMD-3	36	CMD-3	68	CMD-3	100	CMD-3
5	DMP-1	37	Eng-4	69	Eng-22	101	Eng-40
6	DMP-2	38	Eng-5	70	Eng-23	102	Eng-41
7	DMP-3	39	DMP-11	71	DMP-19	103	DMP-27
8	DMP-4	40	DMP-12	72	DMP-20	104	DMP-28
9	Status	41	Eng-6	73	Eng-24	105	Eng-42
10	RST-1	42	Eng-7	74	Eng-25	106	Eng-43
11	RST-2	43	Eng-8	75	Eng-26	107	Eng-44
12	RST-3	44	Eng-9	76	Eng-27	108	Eng-45
13	RST-4	45	Eng-10	77	Eng-28	109	Eng-46
14	RST-5	46	Eng-11	78	Eng-29	110	Eng-47
15	DMP-5	47	DMP-13	79	DMP-21	111	DMP-29
16	DMP-6	48	DMP-14	80	DMP-22	112	DMP-30
17	RST-6	49	Eng-12	81	Eng-30	113	Eng-48
18	CMD-1	50	CMD-1	82	CMD-1	114	CMD-1
19	CMD-2	51	CMD-2	83	CMD-2	115	CMD-2
20	CMD-3	52	CMD-3	84	CMD-3	116	CMD-3
21	TIME-1	53	Eng-13	85	Eng-31	117	Eng-49
22	TIME-2	54	Eng-14	86	Eng-32	118	Eng-50
23	DMP-7	55	DMP-15	87	DMP-23	119	DMP-31
24	DMP-8	56	DMP-16	88	DMP-24	120	DMP-32
25	TIME-3	57	Eng-15	89	Eng-33	121	CHKSUMH
26	TIME-4	58	Eng-16	90	Eng-34	122	CHKSUML
27	TIME-5	59	Eng-17	91	Eng-35	123	SumCnt
28	TIME-6	60	Eng-18	92	Eng-36	124	PassCnt
29	Eng-1	61	Eng-19	93	Eng-37	125	Spare
30	Eng-2	62	Eng-20	94	Eng-38	126	ENGCHK
31	DMP-9	63	DMP-17	95	DMP-25	127	DMP-33
32	DMP-10	64	DMP-18	96	DMP-26	128	DMP-34

(described further on next 15 pages)

TABLE 7.2
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
0	AENG001A	Synchronization Byte							No Conversion - 5A hex
1	AENG002A	Command 1 ID							Note 1
2	AENG003A	Command 1 LSB							
3	AENG004A	Command 1 MSB							
4	AENG005A	Address of 1st Memory Dump Byte, LSB							Concatenate - No Conversion
5	AENG006A	Address of 1st Memory Dump Byte, MSB							
6	AENG007A	Memory Dump, 1st Byte							No Conversion
7	AENG008A	Memory Dump, 2nd Byte							No Conversion
8	AENG009A	Status							Note 2

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
9	AENG010A	Last Reset Time, Bits 0 through 7							Concatenate 48 Bits (Bytes 9 through 13, and 16)
10	AENG011A	Last Reset Time, Bits 8 through 15							
11	AENG012A	Last Reset Time, Bits 16 through 23							Then Multiply by 0.9765625E-6 Yielding Cumulative Spacecraft Clock Time in Seconds (suggest it be converted to a year, day, seconds output)
12	AENG013A	Last Reset Time, Bits 24 through 31							
13	AENG014A	Last Reset Time, Bits 32 through 39							
14	AENG015A	Memory Dump, 3rd Byte							No Conversion
15	AENG016A	Memory Dump, 4th Byte							No Conversion
16	AENG017A	Last Reset Time, Bits 40 through 47							Concatenate with Bytes 9 through 13
17	AENG018A	Command 2 ID							Note 1
18	AENG019A	Command 2 LSB							
19	AENG020A	Command 2 MSB							

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
20	AENG021A	Current Spacecraft Time, Bits 0 through 7							Concatenate 48 bits (Bytes 20, 21, and 24 through 27)
21	AENG022A	Current Spacecraft Time, Bits 8 through 15							Then Multiply by 0.9765625E-6, Yielding Cumulative Spacecraft Clock Time in Seconds (suggest it be converted to a year, day, seconds output)
22	AENG023A	Memory Dump, 5th Byte							No Conversion
23	AENG024A	Memory Dump, 6th Word, MSB							No Conversion
24	AENG025A	Current Spacecraft Time, Bits 16 through 23							Concatenate Bytes 24 thru 27 with Bytes 20 and 21
25	AENG026A	Current Spacecraft Time, Bits 24 through 31							
26	AENG027A	Current Spacecraft Time, Bits 32 through 39							
27	AENG028A	Current Spacecraft Time, Bits 40 through 47							
28	AENG029A	Spare							No Conversion
29	AENG030A	Spare							
30	AENG031A	Memory Dump, 7th Byte							No Conversion
31	AENG032A	Memory Dump, 8th Byte							No Conversion
32	AENG033A	Spare							No Conversion

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
33	AENG034A	Command 3 ID							Note 1
34	AENG035A	Command 3 LSB							
35	AENG036A	Command 3 MSB							
36	AENG037A	Temperature - Spare Temp. Monitor							No Conversion
37	AENG038A	Temperature - Receiver AGC Section (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
38	AENG039A	Memory Dump, 9th Byte							No Conversion
39	AENG040A	Memory Dump, 10th Byte							No Conversion
40	AENG041A	Temperature - SSU (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
41	AENG042A	Temperature - Ku MTU IF Preamp (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
42	AENG043A	Temperature - Receiver IQ Video Select (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
43	AENG044A	Temperature - Ku TWTA EPC(°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
44	AENG045A	Temperature - Spare Temp. Monitor					-		No Conversion
45	AENG046A	Temperature - C MTU Cal Attenuator (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
46	AENG047A	Memory Dump, 11th Byte							No Conversion
47	AENG048A	Memory Dump, 12th Byte							No Conversion

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
48	AENG049A	Temperature - C MTU RF Preamp (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
49	AENG050A	Command 4 ID							Note 1
50	AENG051A	Command 4 LSB							
51	AENG052A	Command 4 MSB							
52	AENG053A	Temperature - C MTU IF Preamp (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
53	AENG054A	Temperature - C MTU Transmit Power Monitor (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
54	AENG055A	Memory Dump, 13th Byte							No Conversion
55	AENG056A	Memory Dump, 14th Byte							No Conversion
56	AENG057A	Temperature - C SSA GaAs FETS (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
57	AENG058A	Temperature - C SSA Power Converter (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
58	AENG059A	Temperature - Ku MTU Cal Attenuator (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
59	AENG060A	Temperature - Ku MTU Transmit Power Monitor (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
60	AENG061A	Temperature - UCFM (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
61	AENG062A	Temperature - Ku MTU RF Preamp (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
62	AENG063A	Memory Dump, 15th Byte							No Conversion
63	AENG064A	Memory Dump, 16th Byte							No Conversion
64	AENG065A	Temperature - Downconverter (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
65	AENG066A	Command 5 ID							Note 1
66	AENG067A	Command 5 LSB							
67	AENG068A	Command 5 MSB							
68	AENG069A	Temperature - SP DFB Butterfly Board (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
69	AENG070A	Temperature - SP DFB Memory (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
70	AENG071A	Memory Dump, 17th Byte							No Conversion
71	AENG072A	Memory Dump, 18th Byte							No Conversion
72	AENG073A	Temperature - SP ICA Condition Amps (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
73	AENG074A	Temperature - SP ICA A/D Converter (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
74	AENG075A	Temperature - SP Synchronizer (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
75	AENG076A	Temperature - SP ATA (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
76	AENG077A	Temperature - SP Housing (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
77	AENG078A	Temperature - DCG Gate Array (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
78	AENG079A	Memory Dump, 19th Byte							No Conversion
79	AENG080A	Memory Dump, 20th Byte							No Conversion
80	AENG081A	Temperature - LVPS Transformer Mounting Plate (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
81	AENG082A	Command 6 ID							Note 1
82	AENG083A	Command 6 LSB							
83	AENG084A	Command 6 MSB							
84	AENG085A	Temperature - LVPS Boost Regulator Assembly (°C)	-2.7212E+1	8.3270E-1	-8.3257E-3	7.0193E-5	-2.9400E-7	4.9845E-10	Note 3
85	AENG086A	Volt. Mon. - LVPS +12 VDC (V)	0.0	6.8898E-2	0.0	0.0	0.0	0.0	Note 3
86	AENG087A	Memory Dump, 21st Byte							No Conversion
87	AENG088A	Memory Dump, 22nd Byte							No Conversion
88	AENG089A	Volt. Mon. - LVPS +28 VDC (V)	0.0	1.5675E-1	0.0	0.0	0.0	0.0	Note 3
89	AENG090A	Volt. Mon. - LVPS +15 VDC (V)	0.0	8.6614E-2	0.0	0.0	0.0	0.0	Note 3
90	AENG091A	Volt. Mon. - LVPS -15 VCD (V)	0.0	-8.8235E-2	0.0	0.0	0.0	0.0	Note 3
91	AENG092A	Volt. Mon. - LVPS +5 VCD 5% (V)	0.0	3.1746E-2	0.0	0.0	0.0	0.0	Note 3

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
92	AENG093A	Volt. Mon. - LVPS +5 VCD 1% (V)	0.0	3.1746E-2	0.0	0.0	0.0	0.0	Note 3
93	AENG094A	Volt. Mon. - LVPS -5.2 VCD (V)	0.0	-3.0242E-2	0.0	0.0	0.0	0.0	Note 3
94	AENG095A	Memory Dump, 23rd Byte							No Conversion
95	AENG096A	Memory Dump, 24th Byte							No Conversion
96	AENG097A	Volt. Mon. - LVPS -6 VDC (V)	0.0	-3.6437E-2	0.0	0.0	0.0	0.0	Note 3
97	AENG098A	Last Command 7 ID							Note 1
98	AENG099A	Last Command 7 LSB							
99	AENG100A	Last Command 7 MSB							
100	AENG101A	Analog - Ku MTU Transmit Pwr Monitor (W)	3.4145	0.08827	1.03E-4	0.0	0.0	0.0	Note 4
101	AENG102A	Analog - Ku TWTA Cathode Voltage (V)	4918.765	-5.8244	0.0	0.0	0.0	0.0	Note 3
102	AENG103A	Memory Dump, 25th Byte							No Conversion
103	AENG104A	Memory Dump, 26th Byte							No Conversion
104	AENG105A	Analog - Ku TWTA Cathode Current (A)	-5.363E-3	5.2908E-4	-5.2692E-7	0.0	0.0	0.0	Note 4
105	AENG106A	Analog - Ku TWTA Helix Current (A)	-1.529E-4	2.0353E-5	0.0	0.0	0.0	0.0	Note 3
106	AENG107A	Analog - Ku TWTA Bus Current (A)	-0.1127	4.0375E-2	0.0	0.0	0.0	0.0	Note 3

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
107	AENG108A	Analog - C MTU Transmit Power Monitor (W)	1.5025	0.120617	-0.217E-3	0.59E-6	0.0	0.0	Note 3
108	AENG109A	Analog - C SSA RF Power (dBm)	-3.6437	6.963E-2	-1.86E-4	0.0	0.0	0.0	Note 4
109	AENG110A	Analog - C SSA Bus Current (A)	0.8755	-3.771E-3	1.9E-5	0.0	0.0	0.0	Note 4
110	AENG111A	Memory Dump, 27th Byte							No Conversion
111	AENG112A	Memory Dump, 28th Byte							No Conversion
112	AENG113A	Analog - LVPS Altimeter Bus Current (A)	6.8206	-1.0472E-1	8.3448E-4	0.0	0.0	0.0	Note 3
113	AENG114A	Last Command 8 ID							Note 1
114	AENG115A	Last Command 8 LSB							
115	AENG116A	Last Command 8 MSB							
116	AENG117A	Bilevel #1							Note 5
117	AENG118A	Bilevel #2							Note 6
118	AENG119A	Memory Dump, 29th Byte							No Conversion
119	AENG120A	Memory Dump, 30th Byte							No Conversion
120	AENG121A	Write-Prot. Mem. Checksum MSB							Concatenate - No Conversion
121	AENG122A	Write-Prot. Mem. Checksum LSB							
122	AENG123A	Sum Count							No Conversion

TABLE 7.2 (continued)
(Preliminary)
TOPEX ALTIMETER ENGINEERING FRAME

BYTE	MNEMONIC	DESCRIPTION	A	B	C	D	E	F	CONVERSION
123	AENG124A	Pass Count							No Conversion
124	AENG125A	Spare							No Conversion
125	AENG126A	Eng Checksum							No Conversion
126	AENG127A	Memory Dump, 31st Byte							No Conversion
127	AENG128A	Memory Dump, 32nd Byte							No Conversion

TOPEX ALTIMETER
ENGINEERING FRAME NOTES

Note 1 - Last Command ID Interpretation

The Command ID is interpreted as follows:

First Byte

Bit	Definition
0-3	Modulo 16 counter of the number of words received in the current multiword ATA command
4	Spare
5	1 - Command Error; 0 - No error
6-7	Command type:

1 = ATA multiword command (bits 0-3 are counter)

2 = ICA command (bits 0-3 invalid)

3 = ATA single-word command (bits 0-3 invalid)

Second Byte

Command LSB

Third Byte

Command MSB

ICA and ATA command codes are listed in Tables 3.2 and Table 3.3.1b, respectively.

Note 2 - ENG009 (Status) is interpreted as follows:

Value (Hex)	Definition
00	Alt. in Idle mode; no science telemetry
03	Alt. in Standby mode
06	Alt. in Cal-I mode
0C	Alt. in Cal-II mode
09	Alt. in Coarse Acquisition mode
0A	Alt. in Coarse Track mode
05	Alt. in Fine Acquisition mode
0F	Alt. in Fine Track mode
FF	Alt. in reprogram mode; no science telemetry

Note 3 - Polynomial Fits

A polynomial fit of the form $y = A+Bx+Cx^2+Dx^3+Ex^4+Fx^5$, is utilized for these EU conversions, where:

x = raw counts
y = measurement in the appropriate units (degrees Celsius, watts, amps, volts)

For those conversions requiring lower order polynomial fits, the later coefficients are assigned values of 0.00.

Note 4 - Polynomial Fits and Temperature Corrections

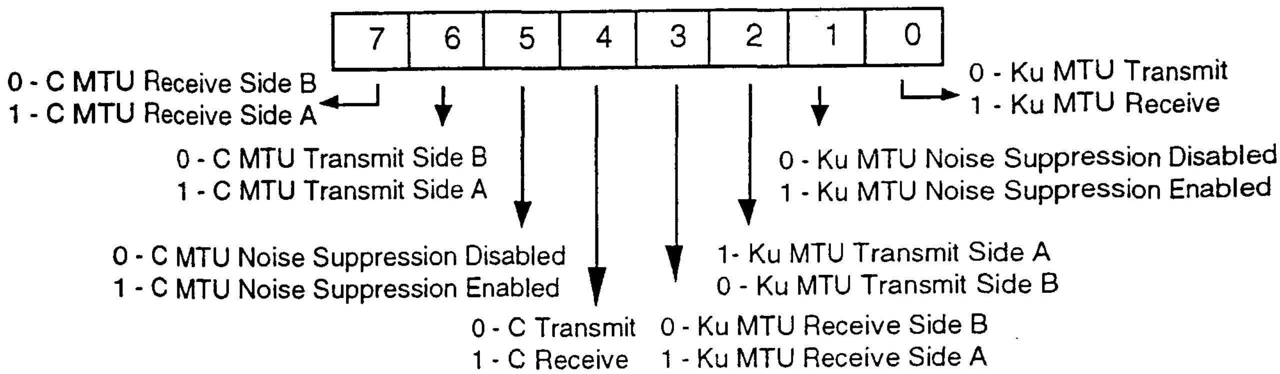
These counts are polynomial-converted per Note 3, and then are temperature-corrected. The form of the additive temperature correction is $y = A+Bt+Ct^2$, where A, B, and C are coefficients unique for each parameter to be corrected, and where:

y = temperature correction to the EU-converted parameter
t = a selected temperature, in degrees Centigrade

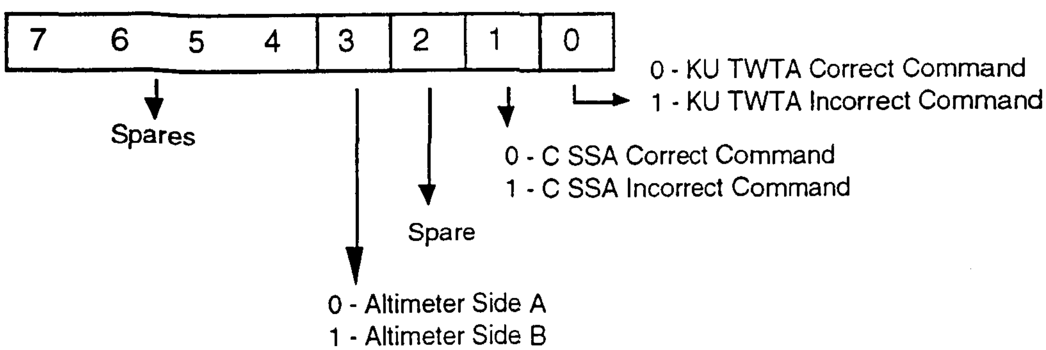
Temperature corrections are applied to four parameters, as follows:

BYTE	DESCRIPTION	A	B	C	SELECTED TEMP.
100	Ku XMIT PWR	3.4500E-1	-5.400E-3	-3.3560E-4	BYTE 59
104	Ku CATH CUR	8.3596E-3	-4.768E-4	5.6966E-6	BYTE 43
108	CSSA RF PWR	1.5864E+0	-5.938E-2	-1.6300E-4	BYTE 56
109	CSSA BUS CUR	8.9400E-2	-3.730E-3	6.0000E-6	BYTE 56

Note 5 - Bilevel #1 Interpretation



Note 6 - Bilevel #2 Interpretation



8.0 HEALTH MONITORS

8.1 Altimeter Monitors

Fifty bytes of the 128-byte engineering frame contain altimeter health monitors. The health monitoring parameters are listed in Table 8.1, with their minimum, nominal, and maximum values.

8.2 Spacecraft Monitors

Health monitors in the spacecraft telemetry are listed in Table 8.2 and Table 8.3.

Table 8.1

ALT ALARM LIMITS

Mnemonic	Assignment	ENGINEERING UNITS Minimum		ENGINEERING UNITS Maximum		TELEMETRY COUNTS Minimum		TELEMETRY COUNTS Maximum		Action	
#		Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Red
AENG029A	spare										
AENG030A	spare										
AENG033A	spare										
AENG037A	Temp Monitor - spare									1	2
AENG038A	AGC Receiver Section Temp (°C)	-9	1	42	52	28	51	165	190	1	2
AENG041A	SSU Temp (°C)	-12	-2	38	48	22	43	155	180	1	2
AENG042A	Ku MTU IF Preamp Temp (°C)	-7	3	43	53	32	56	168	192	1	2
AENG043A	Receiver IQ Video Section Temp (°C)	-5	5	46	56	36	61	175	198	1	2
AENG044A	TWTA EPC Temp #l (°C)	-6	4	37	47	34	59	152	178	1	2
AENG045A	Temp Monitor - spare									1	2
AENG046A	C MTU Cal Attenuator Temp (°C)	-11	-1	43	53	24	46	168	192	1	2
AENG049A	C MTU RF Preamp Temp(°C)	-13	-3	41	51	21	41	163	187	1	2
AENG053A	C MTU IF Preamp Temp (°C)	-13	-3	41	51	21	41	163	187	1	2
AENG054A	C MTU Power Monitor Temp (°C)	-15	-5	40	50	17	36	160	185	1	2
AENG057A	C-SSA GaAs FETS Temp (°C)	-8	2	50	60	30	53	185	206	1	2
AENG058A	C-SSA Power Converter Temp (°C)	7	17	68	78	67	95	219	232	1	2
AENG059A	Ku MTU Cal Attenuator Temp (°C)	-6	4	45	55	34	59	173	196	1	2
AENG060A	Ku MTU Power Monitor Temp(°C)	-8	2	42	52	30	53	165	190	1	2
AENG061A	UCFM Temp (°C)	-4	6	41	49	39	64	162	183	1	2
AENG062A	Ku MTU RF Preamp Temp (°C)	-6	4	44	54	34	59	170	194	1	2
AENG065A	Downconverter Temp (°C)	-4	6	45	55	39	64	173	196	1	2
AENG069A	Signal Proc DFB Butterfly Brd Temp (°C)	13	23	56	66	84	113	198	216	1	2
AENG070A	Signal Proc DFB Memory Temp (°C)	11	21	55	65	78	107	196	214	1	2
AENG073A	Signal Proc ICA Condition Amps Temp (°C)	4	14	49	59	59	87	183	204	1	2
AENG074A	Signal Proc A/D Converter Temp (°C)	7	17	51	61	67	96	187	208	1	2
AENG075A	Signal Proc Synchronizer Temp (°C)	13	23	57	67	84	113	200	218	1	2
AENG076A	Signal Proc ATA Temp (°C)	7	17	51	61	67	96	187	208	1	2
AENG077A	Signal Proc Housing Wall Temp (°C)	0	10	44	54	48	75	170	194	1	2
AENG078A	Digital Chip Generator Gate Array Temp (°C)	26	36	65	75	121	149	214	229	1	2
AENG081A	LVPS Mounting Plate Temp (°C)	2	12	45	55	53	81	173	196	1	2
AENG085A	LVPS Boost Regulator Assembly Temp (°C)	9	19	54	64	72	101	194	213	1	2
AENG086A	LVPS +12V (V)	12.5	13.0	13.8	14.3	181	189	200	208	1	2

Table 8.1
(continued)

ALT ALARM LIMITS

Mnemonic	Assignment	ENGINEERING UNITS Minimum		ENGINEERING UNITS Maximum		TELEMETRY COUNTS Minimum		TELEMETRY COUNTS Maximum		Action	
#		Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Red
AENG089A	LVPS +28V (V)	28.6	29.1	33.8	34.4	182	186	216	220	1	2
AENG090A	LVPS +15V (V)	15.0	15.5	15.9	16.4	173	179	184	189	1	2
AENG091A	LVPS -15V (V)	-14.8	-15.3	-15.7	-16.2	168	173	178	184	1	2
AENG092A	LVPS +5V (5%) (V)	4.5	4.8	5.3	5.6	142	151	167	176	1	2
AENG093A	LVPS +5V (1%) (V)	4.8	5.0	5.2	5.4	151	158	164	170	1	2
AENG094A	LVPS -5.2V (V)	-4.8	-5.1	-5.7	-5.8	159	169	187	192	1	2
AENG097A	LVPS -6V (V)	-5.8	-6.1	-6.2	-6.5	159	167	170	178	1	2
AENG101A	Ku Xmit Power (Watts)		17.6	25.7			138	204		1	
AENG102A	TWTA Cathode Voltage (V)			4225				119		1	
AENG105A	TWTA Cathode Current (Amps)			0.046				110		1	
AENG106A	TWTA Helix Current (Amps)			0.0010				58		1	
AENG107A	TWTA Bus Current (Amps)			2.71				70		1	
AENG108A	C Xmit Power (Watts)			25.4				234		1	
AENG109A	C-SSA Input RF Power (dBm)			0.93				85		1	
AENG110A	C-SSA Bus Current (Amps)			1.1				241		1	
AENG113A	LVPS Bus Current (Amps)			6.6				123		1	
AENG117A	Telltale Byte #1										
AENG118A	Telltale Byte #2										

1 Yellow - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF.

2 Red - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF. Schedule DSN pass for realtime commanding of ALT to standby using SA05 or off using SA07, prepare command sequence, send only if approved by Sensor Engineer.

3 Red - Command ALT off using SA07, notify Sensor Engineer (Brad Burt) and WFF.

Table 8.2

ALT ALARM LIMITS

Telemetry ID	Thermistor Mnemonic	ENGINEERING UNITS Minimum		ENGINEERING UNITS Maximum		TELEMETRY UNITS Minimum		TELEMETRY UNITS Maximum		Action	
		Red	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Red
IM-182	IALTAFT (°C)	-45	-43	33	34.8	32	34	249	254	1	2
IM-184	ILRAFT (°C)	-45	-43	33	34.8	32	34	249	254	1	2
IM-186	ALTCBADK (°C)	-10	0	35	45	41	57	147	178	1	2
IM-187	ALTDWNCP (°C)	-10	0	35	45	41	57	147	178	1	2
IM-188	ALTTMUDK (°C)	-10	0	35	45	41	57	147	178	1	2
IM-189	ALTKUDK (°C)	-10	0	35	45	41	57	147	178	1	2
IM-190	ALTSPPNL (°C)	-10	0	35	45	41	57	147	178	1	2
IM-191	ALTUCFMP (°C)	-10	0	35	45	41	57	147	178	1	2
IM-192	ALTEPCP (°C)	-10	0	35	45	41	57	147	178	1	2
ALTIMETER										1	2
ALT-8	ATMPCHIR	-10	0	35	45	40	52	128	153	1	2
ALT-9	ATMPTWTA	-10	0	55	65	23	30	128	153	1	2
ALT-10	ATMPLVPS	-10	0	35	45	40	52	128	153	1	2
ALT-11	ATMPTWTB	-10	0	55	65	23	30	128	153	1	2
ALT-12	ATMPSSU	-10	0	35	45	40	52	128	153	1	2
SPACECRAFT											
	IMAUN28V (S/C 28V)	TBS				TBS				1	2

1 Yellow - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF.

2 Red - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF. Schedule DSN pass for realtime commanding of ALT to standby using SA05 or off using SA07, prepare command sequence, send only if approved by Sensor Engineer.

3 Red - Command ALT off using SA07, notify Sensor Engineer (Brad Burt) and WFF.

Table 8.3

ALT ALARM LIMITS

Mnemonic	Assignment	Alarm Condition	Action	
			Yellow	Red
AENG001A	Sync Word	≠ 5A	4	
ACME002A ACME018A ACME034A ACME050A ACME066A ACME082A ACME098A ACME114A	Command Error Bit	Bit = 1	1	
AENG017A	Last Reset, Bits 40-47	Change from Previous Value	1	
AENGT12A	Side A or B	Bit = 0	1	
AENGT13A	Side A or B	Bit = 0	1	
AENGT16A	Side A or B	Bit = 0	1	
AENGT17A	Side A or B	Bit = 0	1	
AENGT23A	Side A or B	Bit = 1	1	
ATTCCOTA	CSSA-A CONV OC TRIP	Enabled (=1)	1	
ATTHLOTA	ALT TWTA-A HELIX O/C	Enabled (=1)	1	
ATTLVFEA	ALT LVPS-A FAULT	Enabled (=1)	1	

1 Yellow - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF.

2 Red - Notify SPAT Sensor Engineer (Brad Burt), who in turn notifies WFF. Schedule DSN pass for realtime commanding of ALT to standby using SA05 or off using SA07, prepare command sequence, send only if approved by Sensor Engineer.

3 Red - Command ALT off using SA07, notify Sensor Engineer (Brad Burt) and WFF.

4 Yellow - Indicates a bad data frame. Disregard other alarms when this alarm is set. If alarm persists more than 10 times, notify Sensor Engineer (Brad Burt).

9.0 SEU UPSETS

SEU Upsets are identified from the engineering data stream by monitoring the last reset time words (AENG010A, AENG011A, AENG012A, AENG013A, AENG014A and AENG017A). Any change that is not attributable to the commanding sequence should be considered an SEU. For any unexpected change, the following verifications need to be made.

1. Ensure the ALT has returned to the operate mode which was last write-protected in memory.
2. Ensure s/w checksum and spare bytes contain proper values.
3. Ensure no parameters are in alarm state.
4. Ensure memory dump addresses are correct.

If any of the above criteria are not met, then the adaptive tracker must be reset. This is done only after proper notification to WFF. It also requires reinitialization of previous command states.

10.0 WFF CONTACTS

The NASA Altimeter operations contacts at Wallops Flight Facility are:

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11.0 REFERENCES

TOPEX Radar Altimeter Flight User's Guide (Draft), JHU/Applied Physics Laboratory, January 1990.

Mine, M.R., 1990, Jet Propulsion Laboratory Interoffice Memorandum 3131-90-142.

Mine, M.R., 1990, Jet Propulsion Laboratory Interoffice Memorandum 3131-90-141.

TOPEX Radar Altimeter Flight Software Design, JHU/Applied Physics Laboratory, January 1991.

APPENDIX A

ALTIMETER MODE

COMMAND DESCRIPTIONS

Note: Bits that should retain their last commanded value are given as "*" in the command codes in this appendix. An "x" in a bit location denotes that, for that particular command, the assigned bit value does not matter. An "S" denotes that it should remain in the appropriate side: S=1 for Side A, S=0 for Side B. The letter "C" denotes that, if desired, this bit should be set to zero to save next ATA command(s) into the last mode command.

IDLE

After a power-on reset, the altimeter enters Idle mode automatically; the altimeter may also be commanded to Idle mode. In this mode, the altimeter does not transmit, and the receivers are protected. Engineering telemetry is produced, but science telemetry is not.

Method

To enter Idle mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1S00 011C *0**	Single-word command mode; unwrite-protect the Last Mode Com. NOTE: Use this after an error reset.
ATA	0001 0000 0000 0011	Put the altimeter in Idle mode.
ICA	XXX0 1S00 0111 *0**	Write-protect memory. NOTE: This command is required only if memory has been unwrite-protected to change the Last_Mode_Com.

Note: To avoid CSSA RF Droop, disable C power amplifier gating in IDLE (especially from STBY).

Expected Results

At the next science telemetry frame boundary, the science telemetry stream will cease. The status byte in the engineering telemetry will contain the code 00_H, indicating that the altimeter is in Idle mode.

STANDBY

In Standby mode (excluding Standby test modes), the altimeter does not transmit. The receivers are protected. Both engineering and science telemetry are produced. The height and AGC are fixed.

After entering Standby mode following a power-on reset, a primary channel must be selected to properly initialize the altimeter parameters.

Method

To enter Standby mode for the first time following a power-on reset, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1S00 011C *0**	Single-word command mode; unwrite-protect the Last_Mode_Com. Required before PRIMKU/C. NOTE: Use this command only if the altimeter should operate in Standby after an error reset.
ATA	0001 0000 0000 0110	Put the altimeter in Standby mode.
ATA	0000 0001 0010 0001	Select Ku as the primary channel.
	OR	
ATA	0000 0000 0010 0001	Select C as the primary channel.

Command Type	Command Code	Command Description
ICA	XXX0 1S10 0111 *0**	Write-protect memory. NOTE: This command is required after 0121/0021 if memory is to be protected.

To enter Standby mode at any other time, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1S00 011C *0**	Single-word command mode; unwrite-protect the Last_Mode_Com. NOTE: Use this command only if the altimeter should operate in Standby after an error reset.
ATA	0001 0000 0000 0110	Put the altimeter in Standby mode.
ICA	XXX0 1S10 0111 *0**	Write-protect memory. NOTE: This command is required only if memory has been unwrite-protected to change the Last _Mode_Com.

Expected Results

When changing from Idle to Standby, within one telemetry interval a science frame sync will appear in the altimeter science data bytes of the spacecraft data. When changing from any mode other than Idle to Standby, the transition will take place at the end of the current science data frame.

The status byte in the engineering telemetry will change to 03_H, to indicate that the altimeter is in Standby. The current mode bits in the first Standby altimeter science data frame will be 3_H, to indicate Standby mode. The synchronizer mode bits will be set as follows:

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	0
5	KuTWTOUT	0
7	Operate/Calibrate	0
10	T/R Switch Enable	0

When the altimeter is commanded to Standby, the height, height rate and AGC are all set to a fixed value, and will not change. The standby test modes can affect the value of these data.

CALIBRATE

Calibrate mode provides data for in-flight calibration of the altimeter. A single calibrate command causes the Altimeter to exercise two distinct calibration modes. In the first, Cal-I, the transmitted pulse is fed back through a series of attenuators. The resultant spike is tracked. The telemetered height, AGC, and waveforms give the calibration information.

When all Cal-I attentuator steps are complete, the flight processor automatically changes to Cal-II mode. Cal-II is identical to Standby, except that the AGC is tracked. The altimeter will stay in Cal-II mode until commanded to Standby. When commanded to Standby, the tracked AGC will be saved for use in determining the starting AGC value used in Track mode, during Coarse Acquisition.

Method

To enter Calibrate mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1S01 011C *0**	Single-word command mode; unwrite-protect the Last Mode Com. NOTE: Use this command only if the altimeter should operate in Calibrate after an error reset.
ATA	0001 0000 0000 1100	Put the altimeter in Calibrate mode.
ICA	XXX0 1S11 0111 *0**	Write-protect memory. NOTE: This command is required only if memory has been unwrite-protected to change the Last Mode Com.

Expected Results

The status byte in the engineering telemetry will be 06_H and the current mode bits in the science telemetry will be 6_H to indicate that the ATA is in Cal-I mode. The calibrate attenuator settings in the science data frame should increment about once every 5 science data frames. The synchronizer mode bits will be set as follows for Cal-I:

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	0
5	KuTWTOUT	0
7	Operate/Calibrate	0
10	T/R Switch Enable	0

After about 160 science data frames, Cal-I mode will terminate on a science telemetry frame boundary, and Cal-II mode will begin. The status byte in the engineering telemetry will be OC_H, and the current mode bits in the Cal-I science data frames will be C_H to indicate Cal-II mode. The synchronizer mode bits will be set as follows for Cal-II.

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	0
5	KuTWTOUT	0
7	Operate/Calibrate	0
10	T/R Switch Enable	0

TRACK

In track mode, the altimeter transmits and receives; it generates both engineering and science telemetry.

When commanded to Track mode, the flight software begins a search for the signal at low resolution. After acquiring the signal, it will track for at least one-half telemetry interval at low resolution. Once tracking has been satisfactorily established at low resolution, the software will either institute another acquisition procedure at high resolution, or will begin tracking at high resolution immediately, depending on the signal quality. All changes between tracking and acquisition and high and low resolution are controlled by the flight software, once a Track command has been received.

Method

To enter Track mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1S01 0110 *0**	Single-word command mode; unwrite-protect the Last Mode Com. NOTE: Use this command only if the altimeter should operate in Track mode after an error reset.
ATA	0001 0000 0001 1000	Put the altimeter in Track mode.
ICA	XXX0 1S11 0111 *0**	Write-protect memory. NOTE: This command is required only if memory has been unwrite-protected to change the Last Mode Com.

Expected Results

Following this sequence of commands, the transition to Track will take place at the end of the current science data frame. Note that in Track mode, the flight software can change from acquisition to tracking, and from high to low resolution on half-telemetry frame boundaries; thus, the two sets of current mode bits in the science data telemetry frame can be different. Because the engineering status byte is updated only once every 8.192 seconds, it will not necessarily follow all the changes in tracking mode described below.

The status byte in the engineering telemetry will change to 09_H, and the first current mode byte in the first Track altimeter science data frame will be 9_H, to indicate Coarse Acquisition mode. The bandwidth bit in the Operation Mode Byte will be 1, for low resolution. The height will scan over the programmed acquisition range. The synchronizer mode bits will be set as follows for Coarse Acquisition:

Bit	Description	State
0	Ku PRF Select	1
4	CAMPOUT	1
5	KuTWTOUT	1
7	Operate/Calibrate	0
10	T/R Switch Enable	0

When the signal is acquired, the engineering status byte will be OA_H and the Current Mode bits in the science data frame will be A_H to indicate Coarse Tracking. The bandwidth bit in the Operation Mode Byte will be 1, for low resolution. The height, height rate, and AGC will be the tracked values. The synchronizer mode bits will be set as follows in Coarse Tracking:

Bit	Description	State
0	Ku PRF Select	1
4	CAMPOUT	1
5	KuTWTOUT	1
7	Operate/Calibrate	0
10	T/R Switch Enable	0

When tracking has been established in low resolution, the flight software may start a fine-acquisition sequence. If so, the engineering status byte will be 05_H and the current mode bits will be 5_H to indicate Fine Acquisition. The bandwidth bit in the Operation Mode Byte will be 0, for high resolution. The height will scan over the programmed acquisition range. The synchronizer mode bits will be set as follows for Fine Acquisition:

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	1
5	KuTWTOUT	1
7	Operate/Calibrate	0
10	T/R Switch Enable	0

If a high-quality track is established in Coarse Tracking, or if a signal is found in Fine Acquisition, then the flight software will begin tracking in high resolution. The engineering status byte will be OF_H and the current mode bits will be F_H to indicate Fine Tracking. The bandwidth bit in the Operation Mode Byte will be 0, for high resolution. The synchronizer mode bits will be set the same as for Fine Acquisition. Height, height rate, and AGC will be the tracked values.

As described above, the transitions between acquisition and tracking and high and low resolution are controlled by the flight software. They are a function of the interaction between the programmable parameters and the signal characteristics, and cannot be exactly predicted in advance. The Mode Change Type byte in the science data frame contains information indicating the conditions which caused a change in mode. Certain kinds of behavior may be diagnostic of incorrect programmable parameter settings:

Symptom	Cause of Error
Signal is never acquired in coarse acquisition.	The signal is not the range set by the minimum and maximum scan heights.
	The primary channel is Off.
The mode never changes to fine acquisition or tracking.	The programmable thresholds for changing to high resolution are set too tight.

Symptom	Cause of Error
The mode ping-pongs between coarse and fine track.	The programmable thresholds for changing to low resolution are too tight.

APPENDIX B

TEST MODE SUBSETS OF ALTIMETER MODE COMMANDS

Note: Bits that should retain their last commanded value are given as "*" in the command codes in this appendix. An "x" in a bit location denotes that, for that particular command, the assigned bit value does not matter.

USING THE TEST MODES

Test modes are special subsets of the normal major operating modes. They cause minor variations in the way a mode performs, to provide extra control for testing the altimeter functions. For example, Freeze Calibrate Attenuator test mode keeps the calibrate attenuator setting from changing during Cal-I (as it normally does every 5 seconds). The test modes are meaningful only in the mode of which they are a subset - e.g., Freeze Calibrate Attenuator has no effect in Track mode.

The Enable/Disable state of the test modes is stored in write-protected RAM. Thus, RAM must be unwrite-protected prior to sending a test mode command (both test mode On and test mode Off commands). Prudence demands that memory be re-write-protected after sending a test mode command. Each command sequence below unwrite-protects memory prior to the actual test mode command, and re-write-protects it afterwards. However, if a number of test mode commands are going to be sent one after another (for example, commands to freeze and unfreeze the calibrate attenuators), then it will be most efficient to unwrite-protect memory once, at the start, and re-write-protect memory once, at the end of all the test mode commands.

Error resets do not affect the test modes; if a test mode is enabled prior to an error reset, it will be enabled after recovery from the error reset.

INTERFERENCE SCAN

The Interference Scan is a subset of Standby. It is identical to Standby except that the height is slowly scanned over a programmable range, and the AGC is tracked. The telemetered waveforms can be examined for interference.

Method

To start an Interference Scan, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*10 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0010 0110	Interference Scan On
ICA	XXX0 1*10 0111 *0**	Write-protect memory.

To end an Interference Scan, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*10 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0010 0110	Interference Scan OFF
ICA	XXX0 1*10 0111 *0**	Write-protect memory.

Expected Results

The Iscan bit in the test mode byte of the science data frame will be 1, to indicate that an Interference Scan is in progress. The synchronizer mode bits will stay as they were in normal Standby mode. The height will scan over the programmed range.

When the Interference Scan Off command sequence is sent during an Interference Scan, the height will retain its latest value from the Interference Scan when the normal Standby mode resumes. The Iscan bit in the test mode byte of the science data frame will be 0. Sending the Interference Scan Off command sequence when no Interference Scan is in progress has no effect.

TRANSMIT TEST/TRANSPONDER CODE

This test mode is a subset of Standby. It operates like Standby, except that the altimeter transmits in this mode. The initial height and height rate are programmable parameters. The altimeter can transmit in either high or low resolution in this mode.

Method

To start a low-resolution Transmit Test/Transponder mode send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*11 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM; Transmit On.
ATA	0000 0001 0010 1010	Low-resolution Transmit Test On.
ICA	XXX0 1*11 0111 *0**	Write-protect memory.

To end a low-resolution Transmit Test/ Transponder mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*11 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0010 1010	Transmit Test Off.
ICA	XXX0 1*10 0111 *0**	Write-protect memory; Transmit Off.

To start a high-resolution Transmit Test/Transponder mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*11 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM; transmit On.
ATA	0000 0001 0010 0111	High-resolution Transmit Test On.
ICA	XXX0 1*11 0111 *0**	Write-protect memory.

To end a high-resolution Transmit Test/Transponder mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*11 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0010 0111	Transmit Test Off.
ICA	XXX0 1*10 0111 *0**	Write-protect memory; transmit Off.

Expected Results

After the Transmit Test/Transponder Mode On command series is sent, the altimeter will begin transmitting. The height will change to the programmed height, and while the altimeter is in this test mode, will change at the programmed height rate. The XMit Test bit in the test mode byte of the science data frame will be 1, to indicate that Transmit Test/Transponder mode is in enabled. The bandwidth bit of the Operation Mode Byte of the science data frame will be 1 if low resolution was commanded; it will be 0 if high resolution is commanded. The synchronizer mode bits will be set as follows:

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	1
5	KuTWTOUT	1
7	Operate/Calibrate	0
10	T/R Switch Enable	0

When the Transmit Test/Transponder mode Off command sequence is sent, the height will retain its last value from the Transmit Test in normal Standby mode. The XMit Test bit in the test mode byte of the science data frame will be 0.

It is possible to command both the high- and low-resolution Transmit Test / Transponder mode On at the same time (by sending the two On commands one after the other). If this occurs, the low resolution mode takes precedence; that is, the low-resolution test will start whenever it is commanded, and the high-resolution test will be interrupted, or will not start until the low-resolution test is commanded Off. This occurrence is not reported as an error.

HEIGHT BIAS CALIBRATE MODE

This mode is a subset of the Cal-I part of Calibrate mode. The altimeter is in its hardware calibrate mode, as in Cal-I, but the high impedance switches are in the normal operating position. Instead of tracking height, as in Cal-I, the height is scanned over the possible fine height range. The purpose of this mode is to calibrate the height bias.

Method

To enter Height Bias Calibrate mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0010 1001	Height Bias Calibrate Mode On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn off Height Bias Calibrate mode, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Singleword command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0010 1001	Height Bias Calibrate Mode Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After sending the Height Bias Calibrate On commands, the MSB-1 of both calibrate attenuator settings will be 1, to indicate that that altimeter is in Height Bias Calibrate mode. If the Height Bias Calibrate On commands are sent while the altimeter is in the Standby or Cal-II modes, it will have no effect on the altimeter operations. If the altimeter is commanded to Calibrate after sending the commands, or if it is in the Cal-I mode when the commands are sent, then the fine height will sweep the possible range in 130 steps, and then will repeat until the mode is commanded Off. The synchronizer control bits will be set as follows:

Bit	Description	State
0	Ku PRF Select	0
4	CAMPOUT	1
5	KuTWTOUT	1
7	Operate/Calibrate	1
10	T/R Switch Enable	0

When the Height Bias Calibrate Off commands are sent, the height will return to the last value it had in normal Cal-I, and normal Cal-I tracking will resume. The MSB-1 of the attenuator setting will be 0, to indicate that the Height Bias Calibrate mode is Off.

FREEZE CALIBRATE ATTENUATOR

This mode is a subset of Calibrate (Cal-I). It causes the calibrate attenuator(s) to be frozen at its current value when the command is processed. Cal-I mode will not terminate while this mode is enabled, since both attenuator settings cannot increment to their maximum value.

Method

To freeze the Primary channel calibrate attenuator, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0001	Freeze Primary channel attenuator.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To freeze the Secondary channel calibrate attenuator, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0000	Freeze Secondary attenuator.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To unfreeze the Primary calibrate attenuator, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Singleword command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0001	Unfreeze Primary attenuator.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To unfreeze the Secondary channel calibrate attenuator, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0000	Unfreeze Secondary channel attenuator.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

If the Freeze Calibrate Attenuator commands (either primary or secondary) are sent, the MSB of the appropriate calibrate attenuator setting (Primary Attenuator setting for a Freeze Primary Channel Attenuator command, etc.) in the science data frame will be 1, to indicate that that attenuator setting is frozen. If the Freeze Calibrate Attenuator commands are sent while the altimeter is in Standby or Cal-II modes, they will have no effect on the altimeter operations. If the altimeter is commanded to Calibrate after the commands are sent, or if it is in the Cal-I mode when the commands are sent, then the affected attenuator setting will not change as long as the attenuator setting is frozen. Cal-I mode will not terminate while either attentuator setting is frozen.

The Primary and Secondary channel attenuator settings are independent; one or both may be frozen, and the settings at which they are frozen may be different. If only one is frozen, the other will continue to increment to the maximum attenuation, and then will roll-over to the minimum attenuation.

When the Unfreeze Calibrate Attenuator commands are sent, the frozen attenuator will begin incrementing where it left off. The MSB of the attenuator setting in the science data frame will be 0, to indicate that the setting is not frozen. Note that both attenuator settings must reach their maximum value at the same time before Cal-I will terminate. Either the settings must be unfrozen carefully, so that both attenuators are at the same setting, or the ATA must be commanded to Standby to terminate Cal-I.

FREEZE TRACK

Freeze Track is a subset of Track mode. It freezes the height sent to the synchronizer at the value it had when the Freeze Track command was executed. This height will not change, no matter what the height error and height rate are. The altimeter will not reacquire, even if the signal is completely lost.

Method

To turn Freeze Track On, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0010	Freeze Track On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn Freeze Track Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0010	Freeze Track Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

When the Freeze Track On command series is sent, the LSB of the Test Mode Byte in the science data frame will be 1, to indicate that Freeze Track is on. If the altimeter is in Standby, Coarse Acquisition, or Fine Acquisition mode when the Freeze Track On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Coarse or Fine Tracking after the command series is sent, or is in Coarse or Fine Tracking when the command series is sent, then the height be will frozen at its current value.

When the Freeze Track Off command series is sent, the LSB of the Test Mode Byte in the science data frame will be 0, to indicate that Freeze Track is off. If the altimeter is in Coarse or Fine Tracking when the command series is sent, the altimeter will attempt to track. If the signal has moved too far from the frozen height, a normal acquisition sequence may begin.

COAST TRACK

Coast Track is a subset of Track mode. It updates the height sent to the synchronizer by the height rate; using the values it had for height and height rate when the Coast Track command was executed. The tracker will not update the height and height rate, no matter how large the height error is. The altimeter will not reacquire, even if the signal is completely lost.

Method

To turn Coast Track On, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0011	Coast Track On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn Coast Track Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0011	Freeze Track Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After the Coast Track On command series is sent, the LSB+l of the Test Mode Byte in the science data frame will be 1, to indicate that Coast Track is on. If the altimeter is in Standby, Coarse Acquisition, or Fine Acquisition mode when the Coast Track On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Coarse or Fine Tracking after the command series is sent, or is in Coarse or Fine Tracking when the command series is sent, then the height will change only by the height rate.

When the Coast Track Off command series is sent, the LSB of the Test Mode Byte in the science data frame will be 0, to indicate that Coast Track is off. If the altimeter is in Coarse or Fine Tracking when the command series is sent, the altimeter will attempt to track. If the signal has moved too far from the frozen height, a normal acquisition sequence may begin.

THRESHOLD ONLY

Threshold Only is a subset of Track mode. It prevents the flight software from using the EML method of tracking while in fine tracking.

Method

To turn Threshold Only On, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0100	Threshold Only On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn Threshold Only Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0100	Threshold Only Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After the Threshold Only On command series is sent, the LSB+2 of the Test Mode Byte in the science data frame will be 1, to indicate that Threshold Only is on. If the altimeter is in Standby, Coarse Acquisition, Fine Acquisition, or Coarse Tracking mode when the Threshold Only On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Fine Tracking after the command series is sent or is in Fine Tracking when the commands are sent, then the threshold tracking method will be used, no matter how good the track quality is.

When the Threshold Only Off command series is sent, the LSB of the Test Mode Byte in the science data frame will be 0, to indicate that EML Only is off. If the altimeter is in Fine Tracking when the command series is sent, the normal criteria will be used to determine whether threshold or EML tracking is used.

EML ONLY

EML Only is a subset of Track mode. It prevents the flight software from using the threshold method of tracking while in fine tracking.

Method

To turn EML Only On, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0101	EML Only On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn EML Only Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0101	EML Only Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After the EML Only On command series is sent, the LSB+3 of the Test Mode Byte in the science data frame will be 1, to indicate that EML Only is on. If the altimeter is in Standby, Coarse Acquisition, Fine Acquisition, or Coarse Tracking mode when the EML Only On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Fine Tracking after the command series is sent or is in Fine Tracking when the commands are sent, then the EML tracking method will be used, no matter how bad the track quality is. If the track quality becomes bad enough, the normal reacquisition sequence will take place.

When the EML Only Off command series is sent, the LSB+3 of the Test Mode Byte in the science data frame will be 0, to indicate that EML Only is off. If the altimeter is in Fine Tracking when the command series is sent, the normal criteria will be used to determine whether threshold or EML tracking is used.

It is possible to turn on both the Threshold Only and EML Only test modes at the same time. In this case, Threshold Only takes precedence. This condition is not considered an error.

COARSE TRACK ONLY

Coarse Track Only is a subset of Track mode. It prevents the flight software from using the high resolution while tracking.

Method

To turn Coarse Track Only On, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0001 0001 0110	Coarse Track Only On.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To turn Coarse Track Only Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0110	Coarse Track Only Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After the Coarse Track Only On command series is sent, the MSB-3 of the Test Mode Byte in the science data frame will be 1, to indicate that Coarse Track Only is on. Since the ATA must be in Standby when the Coarse Track Only On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Coarse Tracking after the command series is sent, then the ATA will not go to fine tracking, no matter how good the track quality is. If the signal is lost, the normal reacquisition sequence will take place.

When the Coarse Track Only Off command series is sent, the MSB-3 of the Test-Mode Byte in the science data frame will be 0, to indicate that Coarse Track Only is off.

FINE TRACK ONLY

Fine Track Only is a subset of Track mode. It prevents the flight software from using low resolution while tracking.

To turn Fine Track Only Off, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the test mode control RAM.
ATA	0000 0000 0001 0111	Fine Track Only Off.
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After the Fine Track Only On command series is sent, the MSB-2 of the Test Mode Byte in the science data frame will be 1, to indicate that Fine Track Only is on. Since the altimeter must be in Standby when the Fine Track Only On command series is sent, there will be no effect on the altimeter operations. If the altimeter enters Fine Tracking after the command series is sent, then the ATA will not go to coarse tracking, no matter how bad the track quality is. If the signal is completely lost, the normal reacquisition sequence will take place.

When the Fine Only Off command series is sent, the MSB-2 of the Test Mode Byte in the science data frame will be 0, to indicate that Fine Track Only is off.

Note that it is possible to send both the Coarse Track Only and the Fine Track Only commands while the altimeter is in Standby. In that case, the Coarse Track Only command will take precedence. This condition is not considered an error.

RESET TEST MODES

The Reset Test Modes are four modes which causes various types of watchdog timer errors, plus one mode in which the processor requests its own reset. Their purpose is to test the watchdog timer and reset hardware.

Method

To perform one of the Reset Tests, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX11*** 0111 1011	Single-word command mode; enable error resets; enable reset test commands.
ATA	0101 0000 0000 0010	Send an extra watchdog burst reset.
or		
ATA	0101 0000 0000 0001	Skip a watchdog burst reset.
or		
	0101 0000 0000 0100	Send an extra watchdog track reset.
or		
ATA	0101 0000 0000 0011	Skip a watchdog track reset.
or		
ATA	0101 0000 0000 0101	Request a reset.

Expected Results

After the any one of the reset test commands are set, the processor will be reset by the ICA. The type of reset processing performed by the processor will depend on the setting of the Reset Type bits in the last ICA Command word sent.

APPENDIX C

ANCILLARY

ALTIMETER OPERATIONS

Note: Bits that should retain their last commanded value are given as "*" in the command codes in this appendix. An "x" in a bit location denotes that, for that particular command, the assigned bit value does not matter. Bits that depend on the particular instance are given as "#".

CHANGING THE OPERATING STATE

The performance of the major operating modes and the test modes can be affected by changing the operating state, such as the C channel bandwidth, or the primary channel assignment. The operating state is commanded independently from the operating mode. For example, the setting of the channel bandwidth does not change when the altimeter is commanded from Track to Standby or Calibrate.

The operating state (eg., the C channel bandwidth, the primary channel assignment, etc.) is saved in write-protected RAM, and all assignments commanded prior to an error or ground reset will be in effect after the error reset. However, the part of RAM containing the operating state control variable must be unwrite-protected prior to changing the operating state.

CHANGING THE PRIMARY CHANNEL

The ATA can operate with either the Ku channel primary / C channel secondary, or vice versa. The altimeter uses only the primary channel data for acquisition. The height and height rate are derived from the primary channel; all decisions on "signal found" during acquisition, signal quality and "signal lost" during tracking, are made using primary channel data. Only the secondary height difference is derived from secondary channel data. Although all the primary channel functions may be derived from the C channel, the secondary height tracking algorithms will not function with C primary and Ku secondary; if C is made the primary channel, it is best to turn off the Ku channel.

Note that it is absolutely necessary for correct operation of the flight software that a primary channel be selected after entering Standby mode following a Power-on reset.

Method

To change the primary channel assignment to Ku, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0001 0010 0001	Primary Channel Ku
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To change the primary channel assignment to C, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0000 0010 0001	Primary Channel C
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

The LSB-1 of the Operation Mode Byte will be 0, after sending a command series to change the primary channel to Ku. Further, all telemetry slots assigned to the primary channel will be filled with data derived from the Ku signal.

The LSB-1 of the Operation Mode Byte will be 1, after sending a command series to change the primary channel to C. Further, all telemetry slots assigned to the primary channel will be filled with data derived from the C signal.

SETTING THE HIGH-RATE WAVEFORMS BANDWIDTH ASSIGNMENT

In the science telemetry stream, slots are reserved for ten 64-byte waveforms from one channel (called the high-rate waveform slots) and five 64-byte waveforms from the other channel (the low-rate waveform slots). The channel (Ku or C) assigned to the high-rate slots can be selected by command.

Method

To change the high-rate waveform slots channel assignment to Ku, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0001 0010 0101	High-Rate Channel Ku
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To change the high rate waveform slots channel assignment to C, send the following command(s):

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0000 0010 0101	High-Rate Channel C
ICA	XXXX*** 0111 *0**	Write-protect memory.

Expected Results

In the next complete science data frame after a High-Rate C Waveforms command is sent, the MSB of the Current Mode byte will be set to indicate that the current High-rate/Low-rate assignment is C/Ku. The MSB of the Scaling/Mode Byte for the high-rate waveform will be set, to indicate that the high-rate waveform slots are now filled with C band waveforms; the MSB of the Scaling/Mode Byte for the low-rate waveforms will be set, to indicate that the low-rate waveform slots are filled with Ku waveforms.

In the next complete science data frame after a High-Rate Ku Waveforms command is sent, the MSB of the Current Mode byte will be clear to indicate that the current High-rate/Low-rate assignment is Ku/C. The MSB of the Scaling/Mode Byte for the high-rate waveform will be clear, to indicate that the high-rate waveform slots are now filled with Ku band waveforms; the MSB of the Scaling/Mode Byte for the low-rate waveforms will be clear, to indicate that the low-rate waveform slots are filled with C waveforms.

CHANGING THE C-BAND BANDWIDTH

The C channel can operate in either of two bandwidths: 320 MHz or 100 MHz. The C-channel bandwidth is selectable by command.

Method

To select the 320-MHz bandwidth for the C channel, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0000 0010 1000	C bandwidth—320 MHz
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To select the 100-MHz bandwidth for the C channel, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0001 0010 1000	C bandwidth - 100 MHz
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

In the next complete science data frame after a C bandwidth—320-MHz command is sent, the synchronizer mode bit C BU Limit will be clear.

In the next complete science data frame after a C bandwidth—100-MHz command is sent, the synchronizer mode bit C BU Limit will be set.

TURNING ON AND OFF THE KU-BAND CHANNEL

The Ku-band channel may be turned on and off by command.

Method

To select turn the Ku-band channel On, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0001 0010 0010	Ku band On
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To select turn the Ku-band channel Off, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0000 0010 0010	Ku band Off
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

In the next complete science data frame after a Ku-band On command is sent, the synchronizer mode bit Ku TWTIN Enable will be set, to indicate that the Ku channel is On.

In the next complete science data frame after a Ku-band Off command is sent, the synchronizer mode bit Ku TWTIN Enable will be clear, to indicate that the Ku channel is Off. Note that if Ku is the primary channel and Ku is turned Off, tracking and acquisition are impossible.

TURNING ON AND OFF THE C-BAND CHANNEL

The C-band channel may be turned on and off by command.

Method

To select turn the C-band channel On, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0001 0010 0011	C band On
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

To select turn the C-band channel Off, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the control variable RAM.
ATA	0000 0000 0010 0011	C band Off
ICA	XXX0 1*** 0111 *0***	Write-protect memory.

Expected Results

In the next complete science data frame after a C-band On command is sent, the synchronizer mode bit C AMPIN Enable will be set, to indicate that the C channel is on.

In the next complete science data frame after a C-band Off command is sent, the synchronizer mode bit C AMPIN Enable will be clear, to indicate that the C channel is off. Note that if C is the primary channel and C is turned off, tracking and acquisition are impossible.

CHANGING THE PARAMETER SET

There are four complete sets of parameters selectable by command. Parameter sets 1, 2, and 3 are burned into PROM. Parameter set 4 is programmable from the ground and is located in write-protected RAM. The actual parameters in use by the flight software are called the working parameter set, which is also located in write-protected RAM. To change the parameter set used by the flight software, the part of RAM containing the working parameter set must be unwrite-protected, and the selected set must be copied into the working set.

Method

To select a new parameter set, send the following commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0110 *0**	Single-word command mode; unwrite-protect the working parameter set RAM.

Send one of the following commands:

Command Type	Command Code	Command Description
ATA	0001 0000 0011 0001	Select Parameter Set 1
ATA	0001 0000 0011 0010	Select Parameter Set 2
ATA	0001 0000 0011 0011	Select Parameter Set 3
ATA	0001 0000 0011 0100	Select Parameter Set 4

Wait **at least** two telemetry intervals, then send this command:

Command Type	Command Code	Command Description
ICA	XXX0 1*** 0111 *0**	Write-protect memory.

Expected Results

After this command is executed, bits 2 and 3 of the Operation Mode Byte in the science telemetry will be coded to indicate the parameter set in use. Some effect on the altimeter operations is to be expected, based on what parameters were changed, and how they were changed.

LOADING A NEW PARAMETER SET

New values may be loaded into the User Programmable set from the ground by following the procedures given in this paragraph. Note that new values loaded into the User Programmable set will not be used by the processor (even if the User Programmable set is the currently selected parameter set) until a new Parm Set 4 command is executed.

If any new parameters are desired, the entire parameter set must be uploaded; it is not possible to upload selected portions of the parameter set.

Method

A new User Programmable set of parameters can be uploaded to the flight processor by sending the following sequence of commands:

Command Type	Command Code	Command Description
ICA	XXX0 0*** 0111 *0**	Change command mode to multi-word;
ATA	0110 0110 0000 0000	Parameter load identifier.
ATA	#### #### #### ####	Values for parameters in Table 16 order.
ATA	#### #### #### ####	Value for last parameter in Table 16.
ATA	#### #### #### ####	Checksum for parameter load, including Parameter Load identifier.
ICA	XXX0 1*** 0110 *0**	Change command mode to single-word; Unwrite-protect RAM with User Programmable set;
ATA	0001 0000 0011 0000	Execute command buffer.

Command Type	Command Code	Command Description
Delay at least two telemetry intervals		Give the flight processor time to copy the command buffer to the User Programmable set.
ICA	XXX0 1*** 0111 *0**	Write-protect RAM with User Programmable set.

Expected Results

If sufficient time is allowed between the transmission of the checksum and the transmission of the ICA command returning the processor to single-word command mode, the parameter load should be echoed in the command echo slots of the engineering telemetry stream. Otherwise, this command has no effect on the altimeter operations.

CHANGING THE MEMORY DUMP LIMITS

In each frame of engineering data, the flight processor dumps 32 bytes of processor memory. Following a power-on reset, the range of memory addresses dumped is initialized to the command buffer location. This range may be changed, so that any portion of memory can be dumped, by uploading a new memory dump address range.

Method

The memory dump address range is changed by executing the following sequence of commands:

Command Type	Command Bits	Command Description
ICA	XXX0 0*** 0111 *0**	Change command mode to multi-word;
ATA	0110 0000 0011 0000	Memory Dump Command Identifier.
ATA	#### #### #### ####	Dump start address.
ATA	#### #### #### ####	Dump stop address.
ATA	#### #### #### ####	Checksum for dump addresses, including Dump Command identifier.
ICA	XXX0 1*** 0110 *0**	Change command mode to single-word; unwrite-protect RAM with dump address range.
ATA	0001 0000 0011 0000	Execute command buffer.
Command Type	**Command Bits**	**Command Description**
Delay at least 2 telemetry intervals		Give the flight processor time to copy the command buffer to the dump address location.
ICA	XXX0 1*** 0111 *0**	Write-protect RAM with dump address range.

Expected Results

Although the start and stop address for the memory dump is changed immediately following this sequence of commands, the memory dump bytes contained in the current engineering data frame (i.e., the current spacecraft major frame) are somewhat unpredictable. If the address currently being dumped is less than the new stop address, the dump will continue at the current address until the start of the next engineering data (spacecraft major) frame. If the current address is (or becomes during the current engineering data frame) greater than the new stop address, the dump will continue from the new start address. In any case, at the start of the next engineering data frame, the dump will begin at the new start address. The address bytes of the memory dump will be equal to the new start address.

Note that the start address must be smaller than the stop address, or the start address will be dumped over and over.

REPROGRAMMING

The reprogramming feature of the flight software allows any portion of RAM to be written with uploaded data. Obviously, this is a very powerful tool and therefore its use must be very carefully thought out.

If desired, an entirely new program may be uploaded to the 32K of on-board RAM. Also, the design of the launch flight program incorporates features making the reprogramming of individual modules possible. Paragraph 6.0 of this document, the flight software detailed design documentation, and the flight software code should all be studied carefully before attempting to write a new flight program, or rewrite segments of the launch software.

The process of reprogramming can be summarized as follows: the processor is placed in reprogram mode by sending a "reprogram reset." RAM is unwrite-protected. Then, through a command only valid in reprogram mode, the address of the command buffer is changed to the location in RAM to be loaded with the new program. A multi-word command, consisting of the new program, is uploaded. As with other multi-word commands, the new program is placed in the "command buffer"; that is, the location in RAM pointed to by the new command buffer address. After the entire new program or segment has been loaded, some additional commands are needed to cause the new code to be executed.

Although a new program (or segment) has been loaded, the old launch program is still in control. To cause the old program to execute the new code, at a minimum, the start address of the new code must be placed in a special address table. Other measures may be necessary; paragraph 6.0 describes the means for causing new code to be executed. For the purposes of this summary, we will assume that at least the start address of the new code must be loaded into RAM. A second reprogram reset moves the command buffer back to its original location (since the code in PROM initializes it). Again the command buffer address is changed, this time to the special RAM location where the code start address must be placed. Another multi-word command is used to write the start address in this special location.

If needed, this sequence of reprogram resets, command buffer address changes, and multi-word commands can be used to write new code, addresses, variables, etc. to any number of locations in RAM. When RAM is completely set up so that the new program or program segment is installed (per paragraph 6, the detailed design documentation, and the flight code itself), then a "ground" reset is commanded. If the address tables, etc., have been properly set up by the preceding commands, the new code will be executed when called (immediately, in the case of a complete new program).

There is one important difference between normal multi-word commands, and program segment uploads: program segment uploads should not be followed by a checksum. Particularly when uploading new addresses to tables, etc., the checksum could overwrite important data which should be preserved. The checksum is not useful in any case, since the checksum comparison is performed in the "execute" phase of normal multi-word command execution, and there is no comparison made during program segment uploads.

Two caveats must be noted. First, as the previous discussion implies, there are certain locations in RAM which are used by the launch program during a reprogram attempt–for example, the original location of the command buffer, and the original address tables–and therefore these locations should not be overwritten with new code. Second, a Power-on reset causes the old program in PROM to be reinstated.

Method

New programs may be uploaded to the flight processor using the following sequence of commands:

Command Type	Command Code	Command Description
ICA	XXX0 1*10 0111 0101	Set command mode to single word; Turn off error resets; Turn on auto reset (causes reset); Set reset type to "Reprogram"
ICA	XXX0 0*10 0000 0001	Set command mode to multi-word; Turn off auto reset; Unwrite-protect memory.
ATA	0110 0001 1000 0000	Move Command Buffer identifier.
ATA	#### #### #### ####	New command buffer address–program load will begin at this address.
ATA	#### #### #### ####	Checksum, including Move Command Buffer identifier.
ICA	XXX0 1*10 0000 0001	Set the command mode to single word.
ATA	0001 0000 0011 0101	Relocate command buffer.
Delay at least 2 telemetry intervals		Give the flight processor time to change the command buffer to the new location.

Other Documents in this Series

Volume 1	TOPEX Radar Altimeter Development Requirements and Specifications, Version 6.0, August 1988 (Published May 2003)
Volume 2	WFF Topex Software Documentation Overview, May 1999 (Published May 2003)
Volume 3	WFF TOPEX Software Documentation Altimeter Instrument File (AIF) Processing, October 1998 (Published July 2003)
Volume 4	TOPEX SDR Processing, October 1998 (Published July 2003)
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13. ABSTRACT *(Maximum 200 words)*

This operations handbook identifies the commands for the NASA radar altimeter for the TOPEX/Poseidon spacecraft, defines the functions of these commands, and provides supplemental reference material for use by the altimeter operations personnel. The main emphasis of this document is placed on command types, command definitions, command sequences, and operational constraints. Additional document sections describe uploadable altimeter operating parameters, the telemetry stream data contents (for both the science and the engineering data), the Missions Operations System displays, and the spacecraft and altimeter health monitors.

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