CCR Number: 00010	CRITICALITY: ROUTINE	DUE:03/25/98

DISTRIBUTION SHEET
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NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM EO-1	TITLE B/L S/C TO WARP ICD-026
CCR NO. 0010	ORIGINATOR T. SMITH/GSFC
DATE INITIATED 03/04/98	ORIGINATOR'S CHG. NO. EO-1 ICD-026
DUE DATE	SPONSOR/CODE T. SMITH/WARP LEAD ENG. PHONE x0651

EFFECTIVITY

ITEM: ~~WARP~~
S / N
ITEM:
S / N
ITEM:
S / N

CHANGE CLASS

	I	II
PRELIMINARY	☐	☐
FORMAL	☐	☐

TYPE OF CHANGE

MILESTONE	☐	INTERFACE	☒	SOFTWARE	☐
DOCUMENT	☒	POWER	☐	OTHER	☐
COST ____	☐	WEIGHT	☐	____	☐

DOCUMENTS OR SOFTWARE AFFECTED

EO-1 ICD-026

PROBLEM

The attached draft version of EO-1 ICD-026, EO-1 Spacecraft (SC) to Wideband Advanced Recorder/Processor (WARP) requires baselining. This Interface Control Document (ICD) defines all interface requirements between the WARP and the SC. The WARP is a spacecraft component that receives, stores and processes high rate science data and its associated ancillary data.

PROPOSED SOLUTION

Approve the attached draft version of EO-1 ICD-26 by the EO-1 Level II Configuration Control Board (CCB). Approval of this CCR will officially baseline this draft version of the ICD. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and Preliminary Interface Revision Notices (PIRNs) for CCB approval. This document is maintained by the EO-1 Configuration Management Office (CMO).

BOARD ACTION

APPROVE	☑
APPROVE WITH CHANGE	☐
DISAPPROVE	☐
WITHDRAW	☐

APPROVAL LEVEL REQUIRED

LEVEL I HQS	☐
LEVEL II GSFC	☒
LEVEL III	☐

CRITICALITY LEVEL

EMERGENCY	☐
URGENT	☐
ROUTINE	☒

PROCUREMENT CHANGE ORDER CLASSIFICATION

ROUTINE		URGENT		EMERGENCY	
OPTION 1	☐	OPTION 1	☐		
OPTION 2	☐	OPTION 2	☐		

COMMENTS

Approve to Baseline ICD-26

CHAIRPERSON _____ DATE 30 March 98

EO-1 ICD-26
Draft
February 27, 1998

EO-1 SPACECRAFT TO WIDEBAND ADVANCED RECORDER PROCESSOR (WARP) INTERFACE CONTROL DOCUMENT (ICD)

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

TABLE OF CONTENTS

1.0 SCOPE

This Interface Control Document (ICD) defines all interface requirements between the Wideband Advanced Recorder/Processor (WARP) and the spacecraft. The ICD documents all interface-related agreements concluded between the technology provider and Swales Aerospace, the spacecraft contractor.

The purpose of this document is to specify the interface requirements in order to assure compatibility between the equipment furnished by the respective contractors. Changes to this document may be proposed by either party for formal approval by the EO-1 Project Office.

This ICD will serve as the controlling technical document between the WARP and the EO-1 Spacecraft. This ICD shall apply to all phases of design, assembly, integration, test, launch and operations. This document is controlled by the Goddard Space Flight Center (GSFC) EO-1 project office.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of the ICD to the extent specified herein. In the event of conflict between this ICD and the document referenced herein, the contents of this ICD shall be considered a superseding requirement.

2.1 APPLICABLE DOCUMENTS

SAI-PLAN-130	EO-1 Integration and Test Plan
SAI-PLAN-138	EO-1 Contamination Control Plan
SAI-ICD-027	EO-1 S/C to Instrument FODB Terminal ICD
SAI-SPEC-158	EO-1 Verification Plan and Environmental Specification
A0758	WARP to Spacecraft Interface Control Drawing
	Command Handbook, Litton Amecom
AM149-0031(155)	EO-1 Telemetry Specification, Litton Amecom
AM149-0020(155)	System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom
AM149-0050(155)	Data Systems 1773 ICD EO-1, Litton Amecom
AM149-XXXX(155)	EO-1 X-Band Downlink ICD, Litton Amecom
WARP-735-0013	WARP S-Band ICD
WARP-735-0026	EO-1 Instrument RS-422 ICD
	ICD for Ground Station Interface
	WARP to ALI ICD
	WARP I&T Plan

2.2 REFERENCE DOCUMENTS

GSFC-PPL	GSFC Preferred Parts List (Latest issue)
MIL-M-3810	General Specification for Microcircuits
MIL-S-19500	General Specification for Semiconductors
MIL-STD-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-STD-975	Standard (EEE) Parts List
MIL-STD-202	Test Methods for Electronic and Electrical Components
MIL-STD-883	Test Methods and Procedures for Microelectronics

3.0 INTERFACE REQUIREMENTS

3.1 INTERFACE DEFINITION

The Wideband Advanced Recorder Processor (WARP) is a spacecraft component that receives, stores and processes high rate science data and its associated ancillary data. On the EO-1 mission these science interfaces originate at the Advanced Land Imager (ALI) and the LEISA Atmospheric Corrector (LAC). The WARP then transmits the data to the ground via an X-band or S-band transmitter.

Figure 3.1 shows a block diagram of the WARP and its data interfaces to the spacecraft and instruments.

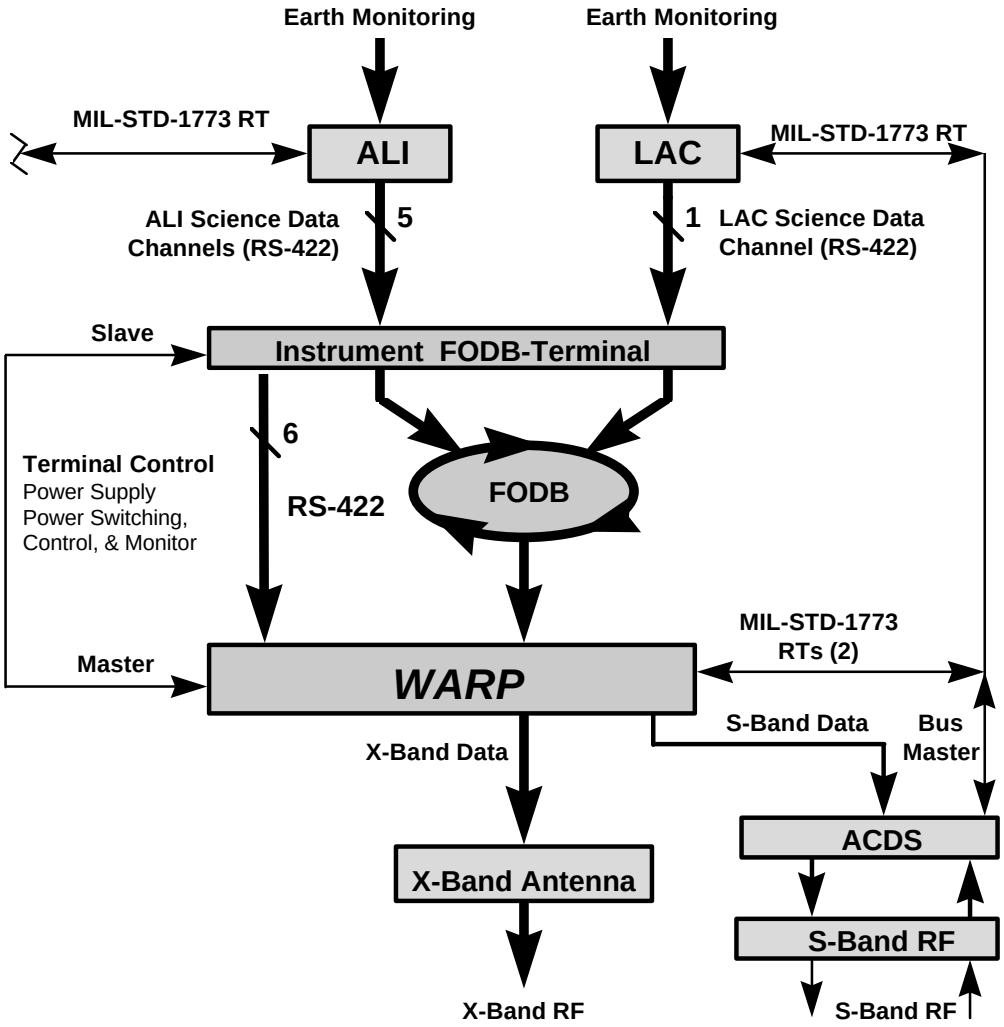

Figure 3.1 WARP Block Diagram

3.1.1 INTERFACE FUNCTIONS

The functions provided to the WARP by the Spacecraft, and conversely, are delineated in the following.

a. 1773 interface for command and telemetry.

b. WARP transfers data to the S-Band transponder via the ACDS.

c. WARP sends high-rate science data to the X-Band Phased Array.

d. Spacecraft provides power at 28 ±7 VDC.

e. Spacecraft provides mounting interface for WARP.

f. Spacecraft provides thermal control during normal and survival operations.

3.2 MECHANICAL INTERFACE REQUIREMENTS

The WARP is mounted on the Bay #1 equipment panel of the spacecraft. Threaded inserts shall be supplied by the spacecraft contractor, on the interior of the panel, for mounting the WARP.

3.2.1 CONFIGURATION

The dimensional drawing of the WARP on the Bay 1 equipment panel is shown in Figure 3.2. Drawing A0758 has complete details of the mechanical interface.

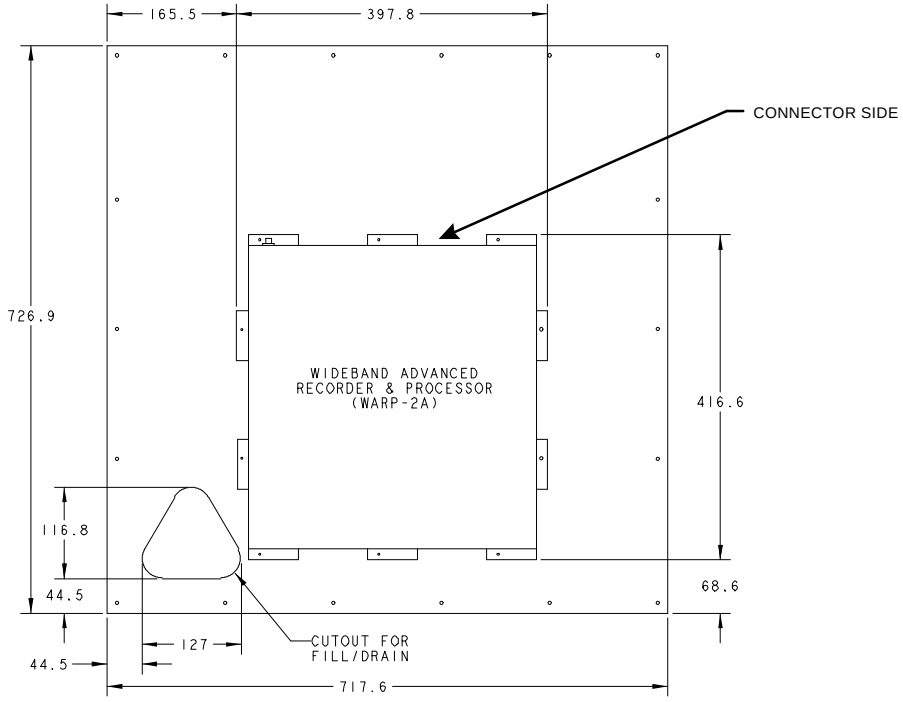

Figure 3.2 WARP Configuration

3.2.1.1 Coordinate System

Orthogonal reference axes are established for the WARP as shown in Figure 3.3.

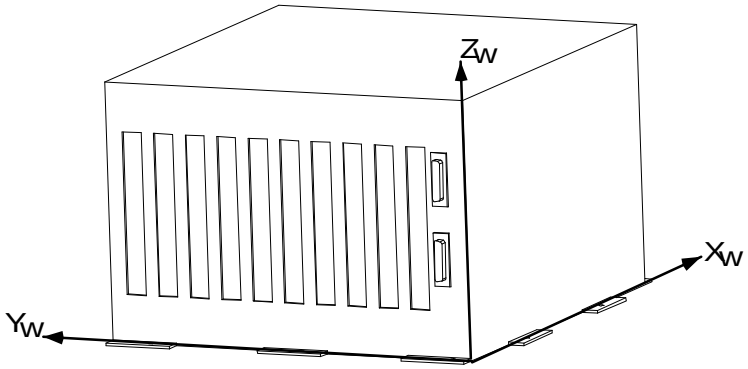

Figure 3.3 WARP Reference Axes

3.2.1.2 Mounting Interface

The WARP is mounted to the spacecraft at 10 attachment points as shown in Figure 3.2.

3.2.1.2.1 Flatness Specification

The mounting points on the spacecraft shall not be out of plane more than 0.25mm.

3.2.1.2.2 In-Plane Accuracy

The mounting point centerlines shall not change more than 0.25mm from nominal.

3.2.2 MASS PROPERTIES

A finite element model of the EO-1 Satellite will be generated to be used in the launch vehicle coupled loads analysis. To aid in this effort, the mass properties of the deliverable hardware will be required.

3.2.2.1 Mass

The total mass of the WARP shall not exceed 27 kg. All changes in mass estimates, including expected growth, shall be reported promptly. The final WARP mass shall be measured to an accuracy of 0.1 kg.

3.2.2.2 Center of Gravity (CG)

The CG of the WARP shall be located, ±12 mm, at X_w= 195 mm, Y_w= 180 mm, Z_w= 122 mm relative to the coordinate system shown in Figure 3.3. The final WARP CG shall be measured to 5% accuracy.

3.2.2.3 Moment of Inertia (MOI)

The MOI of the instrument shall be calculated with 5% accuracy.

3.2.3 MECHANICAL DESIGN AND ANALYSIS REQUIREMENTS

3.2.3.1 Structural Design Safety Factors

All hardware shall be designed and analyzed to the applicable safety factors defined below. The analyses shall indicate a positive margin of safety. Limit loads are defined as the maximum expected flight loads.

Table 3.2 Design Factor

All flight hardware except pressure vessels	Test Qual	Analysis Only
Material Yield Factors =	1.25	2.0
Material Ultimate Factors =	1.4	2.6

3.2.3.2 Loads Environment

3.2.3.2.1 Limit Load Factors

All hardware shall be designed to withstand the quasi-static limit load (with applicable safety factors) defined below. This load should be applied in any direction at the component center of gravity.

Limit Load

±13 g

3.2.3.2.2 Random Vibration

All hardware shall be designed to withstand the random vibration environment (with applicable safety factors) defined in Table 3.1.

Table 3.1 WARP Random Vibration Test Levels

Frequency (Hz)	Acceptance Levels	Protoflight Levels
20	0.013 g^2/Hz	0.026 g^2/Hz
20-50	+6 dB/octave	+6 dB/octave
50-800	0.08 g^2/Hz	0.16 g^2/Hz
800-2000	-6 dB/octave	-6 dB/octave
2000	0.013 g^2/Hz	0.026 g^2/Hz
Overall	10.0 grms	14.1 grms

Notes:

1. Levels are for each of three orthogonal axes, one of, which is normal to the mounting surface and one of, which is parallel to the spacecraft z-axis.
2. Levels to be applied at the interface with the spacecraft equipment panel.
3. Test duration is one minute per axis.
4. The table shows a flight acceptance and protoflight test levels. These levels may be reduced in specific frequency bands, with Project concurrence, if required to preclude damage resulting from unrealistic high amplification resonant response due to the shaker mechanical impedance and/or shaker/fixture resonance.
5. Flight type attach hardware (including any thermal washers, etc.) shall be used to attach the component to the test fixture, and preloads and fastener locking features shall be similar to the flight installation.
6. Cross-axis response of the fixture shall be monitored during the test to preclude unrealistic levels.

3.2.3.3 Structural Stiffness Requirement

In the launch configuration, the WARP shall have a first mode frequency greater than 80 Hz when hard mounted at the flight interface.

3.2.3.4 Stress Analysis Requirement

A stress analysis shall be performed to verify the integrity of the component structure and attachments when subjected to the specified loads with the applicable safety factors. Margins of safety shall be determined, dominant failure modes identified and this information transmitted to the satellite integrator. Existing mechanical stress analysis reports and data may be used if applicable.

3.2.3.5 Fastener Capacity

The deliverable hardware will be attached to the spacecraft panel using threaded fasteners. A positive margin factor of safety shall be maintained for all the fasteners used on the spacecraft. The maximum load on any fastener shall not exceed 667 N (150 lbs) axial and 1223 N (275 lbs) shear.

3.2.4 WARP HANDLING OPERATIONS and LIFT POINTS

3.2.4.1 Handling Operations

Normal care shall be exercised during handling and installation of the equipment.. Protective covers shall be supplied by the WARP contractor for protection of the hardware.

3.2.5 ACCESS REQUIREMENTS

Access requirements to the WARP shall be as defined in WARP I&T Plan. Access requirements include connector mate/demate clearances, removal and replacement clearances for electronic components and protective covers, and access to purge fittings.

3.2.6 APERTURE COVERS

There will be no red-flag cover or other items on the WARP.

3.2.7 THERMAL

The WARP Electronic Box shall be thermally coupled to the Bay #1 spacecraft equipment panel.

3.2.7.1 Heat Flow Across the Interface

The maximum allowable heat flow from all sources and interface temperatures during normal operations and survival operations, is 0.4 watts/sq.in. The WARP base plate at the spacecraft interface shall have an irridite coating with ChoTherm as an interface material between the WARP base plate and the spacecraft.

3.2.7.2 Heat Input to Bay #1 Radiator

The environmental heat flux on the Bay #1 radiator shall be between 0 and 70 watts. The radiator optical properties are for Silver Teflon and 3 mil Kapton. The radiators are sized assuming hot environment and end-of-life degraded thermal coating properties.

3.2.7.3 Design Responsibility

The spacecraft contractor is responsible for the thermal analysis of the combined WARP and spacecraft. The technology provider will supply a thermal design, analysis, and model to the spacecraft contractor.

3.2.7.4 Thermal Coatings and MLI Blankets

GSFC is responsible for all external optical coatings for the WARP. The spacecraft contractor is responsible for all externally-located MLI blankets.

3.3 ELECTRICAL INTERFACE REQUIREMENTS

3.3.0 ELECTRICAL INTERFACES

There are 4 electrical interfaces to the WARP:

- RS-422 from FODB
- Power from PSE
- RS-422 to ACDS
- Terminal control for FODB terminal box

In addition, there are two optical data busses: 1773 and the high-rate FODB

3.3.1 POWER REQUIREMENTS

The spacecraft operating bus voltage and power characteristics are as specified in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM-149-0020(155) and Avionics

Requirements Specification. GSFC shall ensure that the WARP shall successfully operate within this power regime.

3.3.1.1 Power Distribution

The WARP will require a single connector for +28V power input to and return from the WARP LVPC. The WARP will draw 4.6 Amperes at peak and 1.5 Amperes for orbital average. The +28V power input from the spacecraft shall use a DB-9 connector. The wires into the WARP LVPC power input connector shall be 20 AWG. The connector pinout is as follows:

Pin Number	Connection
1	+28V
2	+28V
3	+28V
4	+28V
5	NC
6	GND
7	GND
8	GND
9	GND

The WARP LVPC shall be designed in accordance with the following specification for the spacecraft main power bus as described in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM-149-0020(155):

Electrical Specification	Value
Voltage Regulation	28 ± 7V
Transients	$\leq$ 5V
Ripple and Spikes	$\leq$ 1.5V p-p (DC to 10 MHz)
Inrush Current	< 56A for 1 ms
Harness Output Impedance	per Litton Spec

WARP power consumption is as shown in the following table. Note that these values include the power consumption of the IFT, as its power is provided by the WARP.

	Low Power (LP)	Standy/ Refresh(SR)	Science Collect (SC)	Data Process (DP)	Playback (PB)
WARP + FODB	3 W	31 W	119 W	50 W	74 W

3.3.1.2 Noise Suppression

All inductive loads associated with the WARP, such as relay coil circuits, shall be provided with suppression circuits to prevent excessive transients and associated EMC noise due to power interrupts. Reference System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM-149-0020(155).

3.3.2 WARP to 1773 INTERFACES

The WARP receives and transmits control and status to the spacecraft via a MIL-STD-1773 serial fiber optic bus. See the Data Systems 1773 ICD EO-1, Litton Amecom document AM-149-0050(155), for further details.

3.3.3 WARP to S-BAND TRANSPONDER INTERFACE

The WARP transmits S-Band telemetry downlink data to the spacecraft Command and Data Handling (C&DH) system via a serial RS-422 interface. The S-Band interface will support the 4 Megabit per second rate requirement. See the WARP S-Band ICD (WARP-735-0013) for further details.

3.3.4 WARP to INSTRUMENT RS-422 INTERFACE (Wideband Data)

Science data is transmitted from the instruments to the WARP across a parallel RS-422 interface. This interface will have a throughput capability of 840 Mbits/sec under all operational conditions. See the EO-1 Instrument RS-422 ICD (WARP-735-0026) for further details.

3.3.5 WARP to X-BAND TRANSMITTER INTERFACE

The WARP will provide an X-band modulated output at a rate of 105 Mbps. The WARP will provide fill data for sync acquisition and for unequal length I and Q data streams. See the EO-1 X-Band Downlink ICD (Litton AMXXX) for further details.

3.3.6 ELECTROMAGNETIC COMPATIBILITY

See System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM-149-0020(155).

3.4 ORDNANCE REQUIREMENTS

There are no electro-explosive devices used on the WARP.

4.0 DELIVERABLES

ITEM	DELIVERED BY	DELIVERED TO	NEED DATE	COMMENT
WARP Box	GSFC	Swales	6/24/98	
WARP S/W	GSFC	Swales	6/24/98	
WARP EGSE	GSFC	Swales	6/24/98	
WARP I&T Test Procedures	GSFC	Swales	TBD	
WARP to IFT Harness	GSFC	Swales	4/22/98	

Note: Harness delivered at same time as flight.

EO-1 CCR SPONSOR RECOMMENDATION FORM

CCR NUMBER: 0010

CCR TITLE: BASELINE SC TO WARP ICD 026
CCR SPONSOR: T. Smith

SUMMARY OF COMMENTS RECEIVED: (list Level 4 CCB and internal reviewers who had comments and address those comments)

NONE

DATE: 3/26/98

SPONSOR RESPONSE: Approve as written

SPONSOR/ORGANIZATION: Terry Smith
DATE: 3/26/98