THEMIS
Probe-to-Instrument Data Processing Unit (IDPU)/ ESA Plasma Analyzer Instrument Interface Control Document (ICD)

THM-SYS-101
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Ellen Taylor, U.C. Berkeley THEMIS Mission Systems Engineer

Paul Turin, U.C. Berkeley THEMIS Mechanical Systems Engineer

Kevin Brenneman, Swales Aerospace, THEMIS Spacecraft Systems Engineer

Rob Eppler, U.C. Berkeley THEMIS Spacecraft Mechanical Engineer

Peter Harvey, U.C. Berkeley THEMIS Project Manager

Document Revision Record

Rev.	Date	Description of Change	Approved By
-	6/15/03	Preliminary Draft	-
A	6/25/03	Added FGM Data to SC I/F Added Serial Multiplexed input for High Rate T/M Limiters should not trip on negative currents.	
B	8/29/03	Updated to reflect implementation discussions with SAI Updated Modes Added SOH telemetry	
C	9/4/03	Added 'even' parity statement Changed RS-422 hardware figure Changed text for shield terminated at receiver end only Differential lines added to data connector 1 Hz pulse spans full clock cycle	
D	9/10/03	Added personnel to distribution list Changed low Operational temp to -30C Moved thermistor to LVPS Connector (J101) Removed Status Segment "Sun Time" Moved Sun Pulse description to 4.2.7 Added Sync Marker section Defined 1 Kbps Housekeeping for IDPU Removed Sync Marker in 4.4.3	
E	10/22/03	Added Figures 4.3, 4.4, and 4.5: Swales Modified Section 4.3.2: Swales Updated Section 4.4: Swales Reviewed Swales changes: UCB Merged IDPU (rev E) and ESA (rev D2) ICDs: UCB Added information on ESA/IDPU Access: UCB Updated Section 3.4 (power dissipation by mode): UCB Updated Section 3.5 (IDPU thermal requirements): UCB Table 4-7 (Checksum definition): UCB	
F	11/07/03	UCB Supplies Thermostats, Heaters One Thermistor only for IDPU	
G	02/19/04	Section 2.1 Mechanical Interface: Added various references to new configuration SCM Pre-Amp mounted to IDPU. *Turin/Smith 1/15/04.* Section 2.8.3 Specific Access: Removed ESA Enabling Plug access requirements. *ESA meeting 2/11/04.* Section 3.6.1 Instrument Thermal Monitoring: All Probe monitored thermistors routed through IDPU (TBD-003). *TA e-mail: 12/16/03.* Section 3.6.2 Heaters: Primary/Secondary Instrument heater services routed through IDPU. *TA e-mail: 12/31/03.* Section 3.6.3 Thermal Hardware: YSI Series 44900 thermistors (2.5KOhm) for Probe Bus monitoring, provided by Swales (TBD-004). Removed Section 4.2.6 Thermistor Interfaces. *TA e-mail: 12/12/03.*	

		Section 4.1.1.4 Current Limits: IDPU 28V Service current limited at 4A. *PRH/ERT/Berg 2/17/04.* Boom Actuator Service current limited at 5A (TBD-005). *TA e-mail: 12/23/03.* Section 4.2.1 Timing Interface: Inverted 1PPS signal (active low). *Swales meeting (BK): 1/22/03.* Section 4.2.7 Sun Pulse: output level high (>4V), active low (<1V), 1 msec duration. *RL e-mail: 1/29/04.* Section 4.3.1 Power Connectors: heater services, themistors routed to J201. *PCB schematic: 2/2/04.* Section 4.3.2 Data Connectors: 26-pin HD. *DCB schematic: 12/2/03.* Revised 4.2.5 (added T9 to figure and table). *FHarvey update: 2/16/04.* Added 4.4.4 describing the High Speed Telemetry Interface. *FHarvey update: 2/16/04.* Modified 4.4.2 to note that probe cannot mix data from IDPU packets with probe data. *FHarvey update: 2/16/04.* Section 4.4 Data Interface. Defined Packet APIDs. Changed FGM packet length (22 bytes to 20 bytes). *PRH defined: 2/19/04.*	
H	5/21/04	Updated Mechanical (3/31/04) Updated Thermal (4/9/04) Section 1.3, 3.4 Updated Modes. Section 4.3 and 4.1.1.4 Power and Current Limiters. Updated per Swales meeting 5/6/04 and ECN 008 SPB Doors on 28V Actuator Service. Section 4.4.2 Low Speed Interface. Changed Housekeeping Packets (FGM, SOH, MEM packets) all fixed size, 128 bytes. Packets sent at 750ms mark after 1Hz tick. Changed FGM APID 405, 18 spare.	
AA	5/25/04	Baseline	
AB	6/18/04 10/04/04 10/11/04	ICD Drawing update Transmit packet field "Type=1" was incorrect. Pages 24, 25, 26 have the Type changed to 0. *PRH e-mail: 9/6/04* Added description of Fill Packets, See Section 4.4.4. *DAG e-mail: 10/11/04* Removed TBD procedure in Section 4.4.3. BAU shall count the error.	
AC	11/05/04	ICD Drawing update	
AD	03/11/05	1.5 Reference Documents. Added thermal ICD document 2.5.3 Thermal Gaskets no longer provided by Swales. 2.8.3 Instrument integration site no longer specified. 3. Transferred thermal information to the THEMIS Instrument Thermal Specification, Ref 11. 3.4. Updated Power Dissipation for Safe, Low Power and Science Modes for IDPU. 4.1.1.2 Voltage Ripple. Clarified that IDPU is susceptible	

		to ripple at 100 mV or greater. Removed "(TBC)" 4.1.1.2 Replaced "Swales" by "the BAU" describing voltage ripple generation. Understand Swales regards 100 mV ripple as a goal. 4.1.1.4 Current Limiters. Updated IDPU peak power draw since the peak is 4A on power on. Lowered Actuator service from 5A to 4A since max draw is 2.2 A. Lowered trip time from 28 to 6 msec on services. 4.1.2.1.1. IDPU Inrush lowered from 10 to 6 msec. 4.1.2.2.1. Actuator Inrush lowered from 5A/10msec to 4A/6 msec. 4.1.2.2.3. Added "each" to note that each SPB takes 0.1A running current, and explained that SPB's are deployed in pairs. 4.1.2.2.3. Changed MAG and AXB Actuators to duration to "20-30" seconds at 28V. 4.4.1.1.2 Defined the input field to the checksum. 4.4.1.1.2 Changed temperature coding from "degrees C" to the raw A/D sample. This yields about 1 degree through the -30 to +50C range. 4.4.1.1.2 Changed current measurement range from 1.02A to specific ranges per supply. 4.4.2 Changed the start time of the low speed telemetry output from 750 to 754 msec to 740 to 760 msec. Changed length of time from 30 to 40 msec. Signature Page: Updated the Swales Systems Lead	

Drawing Revision Record

Rev.	Date	Description of Change	Approved By
AA	5/21/04	THM-IDP-ICD-001 Baseline Release	
AB	6/15/04	Updated Panel Cutouts and Finishes	
AC	10/18/04	Added Foot Grip Length	
AD	03/11/05	Updated and improved thermal information	

Distribution List

Name	Email
Peter Harvey, Project Manager, U.C.Berkeley	prh@ssl.berkeley.edu;
Paul Turin, Mechanical Lead, U.C.Berkeley	pturin@ssl.berkeley.edu;
Chris Smith, Thermal Lead, UC Berkeley	csmith@ssl.berkeley.edu;
Ellen Taylor, Mission Systems, U.C.Berkeley	ertaylor@ssl.berkeley.edu;
Manfred Bester, U.C. Berkeley	manfred@ssl.berkeley.edu;
Dorothy Gordon, DCB Engineer, U.C.Berkeley	dag@ssl.berkeley.edu;
Michael Ludlam, IDPU Lead, U.C.Berkeley	mludlam@ssl.berkeley.edu;
Peter Berg, Instrument Lead, U.C.Berkeley	pcb@ssl.berkeley.edu;
Kevin Brenneman, Systems, Swales Aerospace	kbrenneman@swales.com;
Bob Kraeuter, Electrical Systems, Swales Aerospace	rkraeuter@swales.com;
Ginger Robinson, EPS Lead, Swales Aerospace	vrobinson@swales.com;
Mark Hall, Power Board Lead, Swales Aerospace	mhall@swales.com;
Richard LeBoeuf, ACS Lead, Swales Aerospace	rleboeuf@swales.com;
Rommel Zara, Thermal Lead, Swales Aerospace	rzara@swales.com;
Mike Cully, Probe Project Manager, Swales Aerospace	mcully@swales.com;
Rob Eppler, Mechanical Systems, Swales Aerospace	weppler@swales.com;
Steve Hammers, SC Software, Hammers	shammers@hammers.com;
Chris Xenophontos, SC Software, Hammers	cxenophontos@hammers.com;
Kathie Blackman, SC Software, Hammers	kblackman@hammers.com

TBD/TBR List

Identifier	Description
TBR-001	4.1.1.2 BAU conducted noise on the IDPU Power Input of 100mV

Table of Contents

List of Figures

List of Tables

1. Introduction

This document shall describe the interface between the THEMIS Spacecraft Bus (Probe) and the Instrument Data Processing Unit (IDPU), ESA Plasma Analyzer Instrument (ESA) and the Search Coil Magnetometer (SCM) Pre-Amp. The ESA Instrument and SCM Pre-Amp are mounted to the IDPU. Together, they will be delivered as a qualified unit. Each THEMIS Probe shall carry one IDPU/ESA/SCM Pre-Amp Assembly

1.1 Scope

This Interface Control Document (ICD) defines flight hardware interface requirements; mechanical accommodation and thermal modeling requirements; and electrical power and data/information interfaces. A Verification Matrix showing compliance to the interface requirements will be provided as an Appendix. Functional/Performance requirements are found in the requirements database. Environmental test requirements are found in the Verification Plan and Environmental Test Specification.

1.2 ESA Component Description

The ESA instrument measures thermal electrons and ions in the range 5e-30 KeV (electrons) and 10eV-40keV (ions). The basic analyzer design, and the assembly, test and calibration procedures are nearly identical to the ESA Instruments on the FAST Spacecraft.

1.3 IDPU Component Description

The IDPU provides the electronic interface between the Spacecraft bus (Probe) and the Instrument sensors. It collects and formats all instrument data, and controls instrument operations. Reference 2 is a block diagram of the IDPU.

The IDPU consists of a multi-slot 6U VME chassis. The chassis includes a Digital Fields Board (DFB), Boom Electronics Board (BEB), Fluxgate Magnetometer Electronics (FGE)/Power Controller Board (PCB), ESA/SST Interface Card (ETC)/Data Controller Board (DCB), and SST Instrument Digital to Analog Processing Board (DAP). The DCB collects, formats, stores and transmits data from the DFB, FGE and ETC to the Probe. It also accepts commands from the probe and controls instrument operations. The PCB monitors and switches instrument power services, and conditions instrument temperature sensors.

The Low Voltage Power Supply (LVPS), connected to the VME Chassis through a connector, conditions and converts probe power for the instrument electronics and mechanisms.

Operating Modes
The IDPU has a number of independent configurations, which mainly affect Instrument data storage rate. Three basic modes, as described below, effect power consumption and dissipation. A fourth mode, engineering mode, affects the IDPU data rate only:

SAFE POWER MODE - IDPU Power-On State. Core Systems (LVPS, PCB, and DCB) are powered on, all instruments off. Mode is entered on reset (power-on), by ground command, or in response to flag in Probe status field (power-down imminent) in preparation for IDPU load shed. saves power and the contents of SRR.

LOW POWER MODE - IDPU Core Systems (LVPS, PCB, and DCB) and FGM are powered on, all other instruments off. Mode is entered by ground command in preparation for maneuvers (FGM data for attitude determination) or in response to flag in Probe status field (low-power) in case of low power condition.

SCIENCE MODE (Nominal) - Normal operating state, full science data collection. IDPU Core Systems, instrument sensors and associated electronics are powered on. Mode is entered by ground command (instruments are powered on one at a time during early operations).

ENGINEERING MODE - Higher engineering rate and additional telemetry points telemetered. Operational only, typically during ground contact. Mode is typically entered by ground command in preparation for early operations (instrument health and safety diagnostics) and special case instrument operations (boom deploy, high voltage turn-on).

1.4 Document Conventions

In this document, TBD (To Be Determined) means that no data currently exists. A value followed by TBR (To Be Resolved) means that this value is preliminary. In either case, the value is typically followed by UCB (University of California at Berkeley) and / or SA (Swales Aerospace) indicating who is responsible for providing the data, and a unique reference number.

1.5 Reference Documents

The following documents include drawings and documents referenced in this ICD. In the event of a conflict between this ICD and the following documents, this ICD takes precedence. All ICD documents and drawings can be found on the Berkeley THEMIS FTP site:

ftp://apollo.ssl.berkeley.edu/pub/THEMIS/Systems/

1. THEMIS IDPU/ESA ICD Drawing, THM-IDP-ICD-001
2. THEMIS IDPU Block Diagram, thm_sys_201
3. THEMIS IDPU Power Distribution Diagram, thm_sys_202
4. THEMIS IDPU Grounding Diagram, thm_sys_203
5. THEMIS System Grounding Diagram, thm_sys_204
6. THEMIS Instrument Payload Harness Diagram, thm_sys_205
7. THEMIS Command Format Specification, thm_sys_102
8. THEMIS Telemetry Data Format Specification, thm_sys_115
9. THEMIS Power Summary, thm_sys_009
10. THEMIS Mass Summary, thm_sys_008
11. THEMIS Instrument Thermal Specification, thm_sys_119_ith_icd

The ftp site contains the latest released versions of all documents (indicated by letter code at the end of the file name). Please see THEMIS Engineering Document List, thm_sys_000 for all activity on released versions.

The following documents are government documents, provided as references for the Interface Requirements.

1. EWR-127-1: Eastern and Western Range Safety Requirements
2. MIL-HDBK-340A: Application Guidelines for MIL-STD-1540; Test Requirements for Launch, Upper Stage, and Space Vehicles
3. MIL-STD-1522A: Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
4. MIL-STD-1540D: Product Verification Requirements for Launch, Upper-stage, and Space Vehicles

5. NPG 6000.1E: Requirements for Packaging, Handling and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components, dated April 26, 1999

1.6 Units

The drawings contained in this document are dual dimensioned, inches (mm).

2. Mechanical Interface

2.1 Interface Drawing

The mechanical configuration of the IDPU/ESA Assembly is shown in the ICD Drawing, THM-IDP-ICD-001 (Reference 1). The drawing provides all mechanical details including: mass, envelope, mounting location, connector locations, CG location, coordinates, thermal surface finishes, and thermal interface reference.

2.1.1 Instrument Envelopes

The envelope specified is the static envelope, inclusive all assembly hardware and blankets. The actual flight assembly as delivered to Swales shall be within this envelope. Dynamic deflections of the assembly in Launch Mode will be accounted for by Swales as long as the assembly minimum frequency requirement is met.

2.1.1.1 Instrument Stowed Envelope

The IDPU/ESA Assembly Interface Drawing, THM-IDP-ICD-001 is the controlling reference that specifies the Launch mode mechanical interface.

2.1.1.2 Instrument Deployed Envelope

The IDPU/ESA assembly is stationary and does not deploy.

2.2 Coordinate Systems

The assembly coordinate system relative to the assembly interface is shown in the IDPU/ESA Assembly Interface Drawing, THM-IDP-ICD-001. All assembly information is defined relative to this coordinate system.

2.3 Field of View

2.3.1 Field of View

The IDPU/ESA Assembly Interface Drawing, THM-IDP-ICD-001, is the controlling reference that specifies the On-Orbit mode Fields of View.

2.3.2 Field of Travel

The IDPU/ESA assembly is static and does not move.

2.4 Mass Properties

The mass of the IDPU/ESA assembly shall be measured prior to delivery to within ±0.01kg. The Center of Gravity (CG), as documented in THM-IDP-ICD-001 and referenced to the assembly coordinate axes described there, shall be predicted through analysis. The IDPU/ESA assembly is a static assembly so no separate Moments of Inertia for a stowed and deployed case are provided.

2.5 Mounting

2.5.1 Mounting Method

The ESA and SCM Pre-Amp shall be mounted to the IDPU, and the IDPU/ESA/SCM Pre-Amp assembly is mounted to the Probe via the bolted interface shown in the IDPU/ESA Assembly Interface Drawing, THM-IDP-ICD-001.

2.5.2 Mounting Interface

Mounting hole coordinates, dimensions, orientation, and tolerances are shown in the IDPU/ESA Assembly Interface Drawing, THM-IDP-ICD-001. Mounting hole tolerances shall be dimensioned in accordance with ANSI Standard Y14.5M, "Dimensioning and Tolerancing", 1999 or later revisions.

2.5.3 Mounting Hardware

UCB shall provide all of the mounting hardware for the ESA and Pre-Amp to the IDPU. Swales shall provide all the mounting hardware for the assembly to the Probe. Any isolators will be supplied by UCB.

2.5.4 Mounting Surface Requirements

2.5.4.1 Flatness

The mounting surface of the IDPU shall be fabricated to a flatness tolerance of 0.005 inches or less under the IDPU footprint. The ESA foot will be shimmed. IDPU mounting surface characteristics shall be documented in the Instrument Interface Drawing, THM-IDP-ICD-001. Swales shall shim as required to avoid inducing stress.

2.5.4.2 Surface Finish

The mounting surface of the IDPU shall be fabricated to a surface finish of 32 micro-inches RMS or less to ensure the required electrical and thermal contacts as well as the required alignment accuracy.

2.5.5 Mounting Location

The IDPU/ESA assembly location is determined by Swales.

2.5.6 Drill Templates

No drill templates will be required. All IDPU-to-Probe interfaces will match if all conditions of this specification are maintained.

2.5.7 Spacecraft Mounting

2.5.7.1 Orientation During Integration

The ESA/IDPU assembly shall be capable of being installed/removed with the Probe Bus X/Y axes horizontal.

2.5.7.2 Mounting Impacts

The ESA/IDPU assembly shall be capable of being installed or removed during ground operations without degradation, damage or disqualification of the flight hardware.

2.6 Alignment

2.6.1 Alignment Responsibilities

Swales is responsible for aligning the IDPU to the Probe Bus. UCB is responsible for aligning the ESA to the IDPU.

2.6.2 Alignment Requirements

The IDPU shall be placed relative to the bus coordinate system within mounting bolt-hole tolerances.

2.7 Mechanisms

The ESA has once-open covers, closed for launch and throughout most Probe integration and test.

2.8 Access To Instrument

2.8.1 Service Access

The ESA requires purge throughout instrument integration and test as described in the THEMIS Contamination Control Plan, thm_sys_004.

2.8.2 General Access

All items to be installed, removed, or replaced at the Probe Bus/Carrier level shall be accessible without disassembly of the item.

2.8.3 Specific Access

The following table provides a list of test connectors, contamination covers, and any other I&T equipment that must be installed or removed during integration, environmental test or at the launch site. Items for IDPU include a DCB Test Plug and Boom Actuator enable and disable plug. Items for ESA include a anode purge connection and a one shot cover cocking pin connection.

Table 2-1: Access Requirements

Item	Last Access	Function
IDPU DCB Test Plug	Instrument Integration	Provides additional diagnostics during integration
IDPU Actuator Enabling Plug	Launch Site: Probe Carrier Assembly	Provides lock-out of all boom actuator power for mechanical safing
ESA Contamination Covers	Launch Site: Probe Carrier Assembly	Provides contamination protection
ESA Disable Block, Test Cable	Instrument Integration	Provides functional capability and HV, SMA lock-out during testing
ESA Purge	Launch Site: Probe Carrier Assembly	Provides contamination protection

Test Items: All items to be removed prior to test shall be tagged with a red tag stating, "REMOVE BEFORE TEST". All items to be installed prior to test shall be tagged with a green tag.

Flight Items: All items to be removed prior to flight shall be tagged with a red tag stating, "REMOVE BEFORE FLIGHT". All items to be installed prior to flight shall be tagged with a green tag.

2.8.4 Mechanical Test Instrumentation Access

The IDPU/ESA assembly shall accommodate mounting area and access to temporarily installed acceleration sensors and supporting hardware for purposes of monitoring accelerations during Instrument, Probe Bus, and Probe Carrier Assembly ground environmental testing.

3. Thermal Interface

Thermal interface information has been transferred to Ref 11 THEMIS Instrument Thermal Specification, THM_SYS_119_ITH_ICD

3.1 Thermal Design

This section has been moved to Reference 11.

3.2 Thermal Design & Analysis Responsibilities

This section has been moved to Reference 11.

3.3 Heat Transfer

This section has been moved to Reference 11.

3.4 Power Dissipation

As a point of reference, the following table shows the approximate power dissipation of the IDPU and ESA by instrument mode (represents allocated power THM_SYS_009 provides the current best estimate (CBE) power dissipation. Power levels used in thermal modeling are given in Reference 11

Table 3-1: Power Dissipation

Instrument Mode	IDPU Power (W)	ESA Power (W)
INSTRUMENT PAYLOAD off	0 W	0 W
SAFE MODE (IDPU on, ESA off)	6.8W CBE 7.1W Allocated	0 W
LOW POWER MODE (IDPU/FGM on, ESA off)	7.7W CBE 8.0W Allocated	0 W
NOMINAL (SCIENCE) MODE (IDPU on, ESA on)	11.5W CBE 11.8W Allocated	1.8W CBE 2.0W Allocated

3.5 Temperature Requirements

This section has been moved to Reference 11.

3.6 Temperature Monitoring and Control

This section has been moved to Reference 11.

3.7 Contamination Control

This section has been moved to Reference 11.

4. Electrical Interface

The IDPU will be the single-point electrical interface between the probe and the instrument payload. As with all other instruments, the IDPU will condition/distribute power to and receive/format data from the ESA as described in the ETC-to-IDPU ICD. Therefore, the interfaces below only apply to the electrical interface between the IDPU and the Probe.

4.1 Power

The IDPU receives electrical power on four separately switched services. Each service provides unregulated 28 volts.

- **IDPU Power:** Interface for all IDPU electronics. Switched on for all modes.
- **Actuator Power:** Interface for boom mechanisms and motors. Switched on for boom deployments only. This service shall have the appropriate lock-out capability required by safety during ground operations and launch vehicle processing.
- **Primary and Secondary Heater Power:** Interface for Instrument heaters. Heater services are switched on for all modes and controlled by Instrument thermostats.

4.1.1 Probe 28 Volt Service Characteristics

Each Probe 28 Volt service shall have the following characteristics:

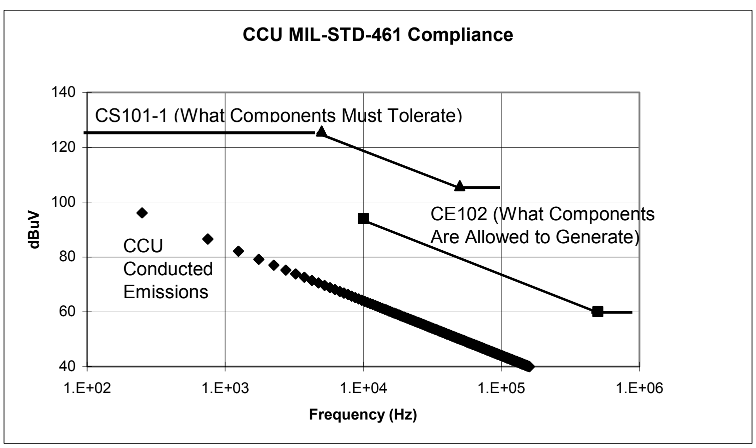
4.1.1.1 Regulation

The Probe 28 Volt services shall be 28 +6/-6 Volts.

4.1.1.2 Voltage Ripple

Voltage ripple on the supply and load as a function of frequency shall be as shown in the following figure. The IDPU and Instrument Payload shall be capable of tolerating w/out damage the levels shown in Figure 4-1. During science operations, the Instrument Payload shall be capable of tolerating 100mV peak ripple on the 28V line w/out degradation of the science measurement. The BAU shall not generate more the 100mV TBR-001(SAI) peak ripple to be verified by conducted emission measurement of the system.

Figure 4-1: Conducted Emission / Susceptibility Specification



4.1.1.3 Voltage Transients

Voltage transients on the supply lines shall not exceed +/- 2 Volts for 1 msec.

4.1.1.4 Current Limiters

The IDPU power service shall be current limited at 4 Amps. Peak power draw occurs during Power On (4A).

The Actuator power service shall be current limited at 4 Amps. Peak power draw occurs during MAG deployment or backup AXB boom deployment (34V/31Ohm x 2 booms = 2.2A).

The Primary and Secondary heater power services shall be current limited at 1.8 Amps.

Current limiters shall reside at the power source and shall act like circuit breakers, requiring a ground-commanded reset and including an override capability. Limiters should not trip on transients less than 6 ms (TBC) in duration, nor trip on negative currents. The circuit breakers shall be designed to not trip on in-rush current as specified in Section 4.1.2.1.1 below.

4.1.1.5 Current Monitors

The Probe shall have current monitors on each power service and include the monitors in the Probe Status telemetry that is transferred to the IDPU.

4.1.1.6 Returns

Each service shall be provided with a separate return line.

4.1.1.7 Harness

Power service and return lines shall be routed as twisted pairs of # 22 AWG wire. The power harness to the IDPU shall have individual shields, or a common over-shield, connected to probe chassis ground at a single point at the source end (see Reference 5).

4.1.1.8 Impedance

Effective line impedance in the service at the instrument connector shall be < 500 milliohms DC-10KHz.

4.1.2 Probe 28 Volt Instrument Loads Characteristics

Each probe 28V service load shall return its current through the provided return line (see Reference 3). The 28V return shall be isolated from signal and chassis ground by at least 1 Mohm and no more than 1μF.

4.1.2.1 IDPU Power Load Characteristics

The IDPU power service runs the instrument electronics.

4.1.2.1.1 Inrush and Transients

In-rush current on the IDPU power service shall not exceed 4 Amps for longer than 6 msec.

4.1.2.1.2 Current Ripple

Current ripple shall not exceed the curve shown in Figure 4-1.

4.1.2.1.3 Power Consumption

Power consumption is a function of instrument operating modes as shown in Table 3-1 above.

4.1.2.2 Actuator Power Load Characteristics

There are four transient loads for boom actuations whose power is switched by the IDPU off the Actuator service. These include:

- Radial (or Spin Plane Boom (SPB)) EFI Doors (Shape Memory Alloy, SMAs)
- Radial (or Spin Plane Boom (SPB)) EFI Motors
- Axial Boom (AXB) EFI Door Actuators (Frangi-bolt)
- Mag Boom Actuators (Frangi-bolt)

Note that other SMA Actuators (ESA Cover and SST Attenuators) are powered from the IDPU Power Service, not the Actuator Power Service.

4.1.2.2.1 Inrush & Transients

In-rush on the Actuator power service shall not exceed 4 Amps for longer than 6 msec.

4.1.2.2.2 Current Ripple

Current ripple shall not exceed the curve shown in Figure 4-1.

4.1.2.2.3 Power Consumption

- Radial (or Spin Plane Boom (SPB)) Doors: Power consumption is approximately 2A @ 28+/-6V, as shown in Reference 3. Door Actuation is approximately 1 second.
- Radial (or Spin Plane Boom (SPB)) Motors: Power consumption is approximately 0.1A each @ 28+/-6V, as shown in Reference 3. SPB's are normally deployed in pairs. Turn-on transient for SPB Motors is approximately 1.7A @ 34V.
- Axial Boom (AXB) Actuators (Frangi-bolt): Power consumption is approximately 1A @ 28+/-6V, transient load lasting 20-30 seconds, as shown in Reference 3.
- Mag Boom Actuators (Frangi-bolt): Power consumption is approximately 2A @ 28+/-6V, transient load lasting 20-30 seconds, as shown in Reference 3.

4.2 Signals

Electrical signals are carried between the IDPU and probe over a single harness. Signals are carried in twisted pairs which can either be individually shielded and/or have a common harness shield connected to chassis ground at the signal source end.

The RS-422 differential logic signal interface circuit is shown in Figure 4-2. Logic levels described in this document are as measured on the harness (these may be inverted by the receiver). The transmission lines are shielded twisted pairs with the individual shield grounded at the driver end only. Provision will be made for termination at the receiver ends (i.e. shield easily grounded at by a jumper if necessary), but it is expected that series termination will be sufficient.

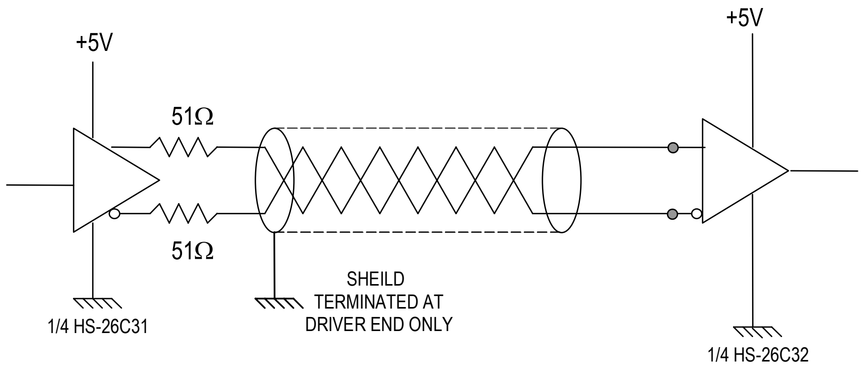
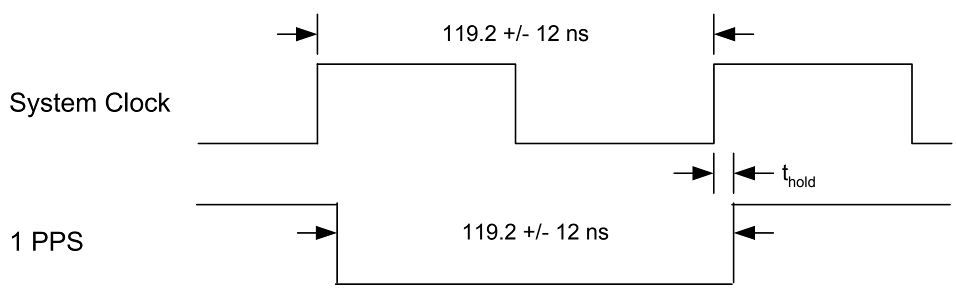


Figure 4-2: RS-422 Interface

4.2.1 Timing Interface

The IDPU receives probe time in the form of two clock signals (1Hz and 8MHz) plus a periodic synchronizing command. The command is described is Section 4.4.1.

The 1Hz clock shall consist of a pulse occurring once per second, based on the stable probe clock as described in Figure 4-3. The 8MHz clock shall be a square wave at F_{1MHZ}= 8,388,608 Hz, also based on the stable probe clock. There shall always be exactly F_{8MHZ} 8MHz clocks per 1Hz clock tic. The signal timing is also shown in Figure 4-3. 1Hz shall be logic low for T_{LO} = 100% ±10% of $(1/F_{8MHZ})$, and the edges of 1Hz shall be synchronous with the falling edge of 8MHz ±10% of $(1/F_{8MHZ})$. The included rising edge of 8MHz corresponds to the actual 1-second time mark.



Notes:
1. System Clock frequency is 8.388608 MHz, duty cycle is 50% +/- 5%
2. The falling edge of 1 PPS is driven by the falling edge of System clock
3. The low level of 1 PPS has a hold time of 0 ns min, 12 ns max

Figure 4-3: Clock Signal Timing

4.2.2 Reset

The IDPU shall be powered off to reset the IDPU to a known state.

4.2.3 Command Interface

The Command interface is a serial interface used to send data from the probe to the IDPU. The information sent over this interface is described in Section 4.4.1. The data is transmitted on a single serial line using UART encoding, and a differential interface. Data shall be transmitted at 38.4k baud, with 1 start bit (asserted low), 8 data bits, 1 parity bit (even), and one stop bit (active high) per 8-bit byte transmitted, as shown in Figure 4-4.

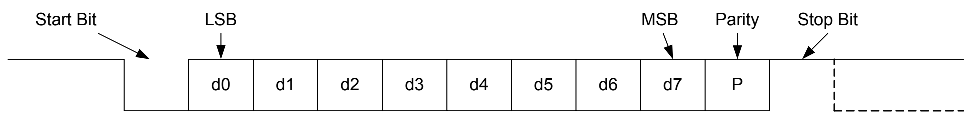


Figure 4-4: Low Speed Command and Telemetry Interface

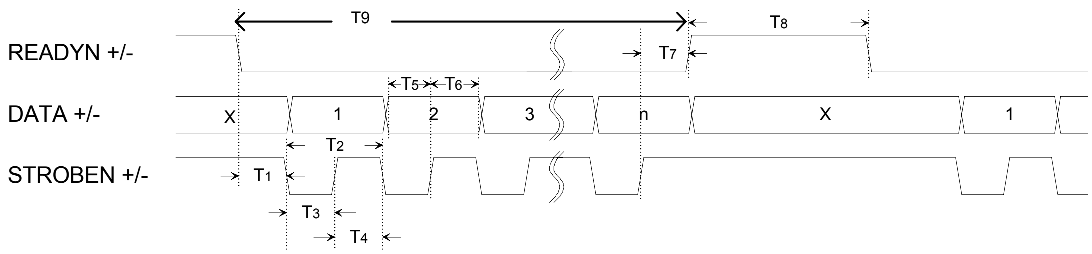
4.2.4 Low Speed Telemetry Interface

The Low Speed Telemetry interface is a serial interface used to send status and housekeeping data from the IDPU to the probe. The data is transmitted on a single serial line using UART encoding, and a differential interface. Data shall be transmitted at 38.4k baud, with 1 start bit (asserted low), 8 data bits, 1 parity bit (even), and one stop bit (active high) per 8-bit byte transmitted, as shown in Figure 4-4.

Note that parity is defined as "even" in the following manner: the eight data bits plus one parity bit are forced by the parity bit to incorporate an even number of ones.

4.2.5 High Speed Telemetry Interface

The High Speed Telemetry interface is bit serial interface used to send full CCSDS telemetry frames from the IDPU to the probe Bus Avionics Unit (BAU). The information sent over this interface is described in Section 0. The characteristics and timing of this interface are diagrammed in Figure 4-5. The protocol is further defined in section 4.4.4.



	Characteristic	Min	Max	Comments
T_1	READYN true to STROBEN+ asserted	0 ns	-	READYN asserted signals BAU ready - assumes IDPU is ready to output data
T_2	STROBEN Pulse Period	477 ns	-	2.1 Mhz Max Rate
T_3	STROBEN Pulse Width (Low)	180 ns	-	
T_4	STROBEN Pulse Width (High)	180 ns	1 sec	STROBEN may remain deasserted if data not available, with limits
T_5	DATA Valid to STROBEN+ Rising edge	-	50 ns	Data Setup time
T_6	STROBEN+ Rising edge to DATA Invalid	180 ns	-	Data Hold time
T_7	STROBEN+ Rising edge to READYN deasserted	200 ns	280 ns	READYN deasserted upon receipt of 'n' data bits
T_8	READYN Deasserted Time	1000 ns	-	READYN may remain deasserted if BAU not ready for more data
T9	READYN Assertion Time	4.2 ms	4.62 ms	Ends on Frame end or timeout

- All signals originate at the IDPU except READYN +/-

- All transitions measured at 50%

- Min/Max at BAU interface

- Data is positive true, must be sampled on rising edge of STROBEN+

- Data Value of 1 for DATA is defined as (DATA+) - (DATA-) > 0.2V
  Data Value of 0 for DATA is defined as (DATA+) - (DATA-) < -0.2V

Figure 4-5: High Speed Telemetry Interface

4.2.6 *Deleted.*

4.2.7 Sun Pulse

A Sun Pulse is provided to the IDPU once per spin, indicating the sun crossing. The Sun Pulse shall have output levels high (>4V), with active low pulse (<1V). The minimum pulse width shall be at least 1 millisecond in duration.

4.3 Connectors & Harnessing

The Probe to IDPU electrical interface shall be made on the three connectors as described below.

4.3.1 Instrument Power Interface Connectors, IDPU-J101 and J201

The low-current power (IDPU power) interface for the IDPU electronics shall be on connector IDPU-J101 on the Low Voltage Power Supply (LVPS). The high-current power (Actuator power) interface for the boom actuators shall be on connector IDPU-J201 on the Power Control Board (PCB). The IDPU-J101 connector on the box shall be a 9-pin normal density male D connector (311P409-1P-B-12). The IDPU-J201 connector on the box shall be a 15-pin high-density male D connector (311P407-1P-B-12). The pin-out and harnessing of these connectors shall be as shown in Table 4-1and Table 4-2

Table 4-1: Connector IDPU-J101 Pinout

Pin	Signal	Signal	Harness
1	SC_IDPU_P28V	IDPU 28V	#22 TP w/ 6
2	SC_IDPU_P28V	IDPU 28V (Redundant)	#22 TP w/ 7
3	N.C	Unused	NC
4	N.C	Unused	NC
5	LVPS_SCTEMP	Probe Monitored Temp Sensor	#26 TP w/ 9
6	SC_IDPU_RTN	IDPU 28V Return	#22 TP w/ 1
7	SC_IDPU_RTN	IDPU 28V Return (Redundant)	#22 TP w/ 2
8	N.C	Unused	NC
9	LVPS_SCTEMP_RTN	IDPU Thermistor Return	#26 TP w/5

Table 4-2: Connector IDPU-J201 Pinout

Pin	Signal	Description	Harness
1	SC_ACT_P28V	Actuator 28V	#22 TP w/ 6
2	SC_ACT_RTN	Actuator 28V Return (Redundant)	#22 TP w/ 11
3	HTR_PRIME_RTN	Primary Heater Service Return	#22 TP w/ 12
4	SPB_SCTEMP	Probe Monitored Temp Sensor	#26 TP w/ 9
5	IDPU_SCTEMP_RTN	Probe Monitored Temp Sensor Return	#26 TP w/ 14
6	SC_ACT_RTN	Actuator 28V Return	#22 TP w/ 1
7	N.C.	Unused	N/C
8	HTR_SECOND_PWR	Secondary Heater Service Power	#22 TP w/ 13
9	SPB_SCTEMP_RTN	Probe Monitored Temp Sensor Return	#26 TP w/ 4
10	SST_SCTEMP	Probe Monitored Temp Sensor	#26 TP w/ 15
11	SC_ACT_P28V	Actuator 28V (Redundant)	#22 TP w/ 2
12	HTR_PRIME_PWR	Primary Heater Service Power	#22 TP w/ 3
13	HTR_SECOND_RTN	Secondary Heater Service Return	#22 TP w/ 8
14	IDPU_SCTEMP	Probe Monitored Temp Sensor	#26 TP w/ 5
15	SST_SCTEMP_RTN	Probe Monitored Temp Sensor Return	#26 TP w/ 10

TP is twisted pair

4.3.2 Signal Interface Connector, IDPU-J301

The signal interface from the IDPU to the probe shall be on connector IDPU-J301 on the IDPU Data Controller Board (DCB). The connector on the box shall be a 26-pin high-density male connector (311P407-2P-B-12). The pin-out and harnessing of this connector shall be as shown below.

Table 4-3: Connector IDPU-J301 Pinout

Pin	Signal	Description	Harness
1	IDPUTLM_P	Slow Telemetry (IDPU_STLM+)	#24 TSPI w/ 11
2	IDPUSTROBE_P	High-Speed Data Clock (IDPU_STROBEN+)	#24 TSPI w/ 12
3	IDPU_DATA_P	High-Speed Data (IDPU_DATA+)	#24 TSPI w/ 13
4	BUS8MHZ_P	8.38 MHz Clock (CLK8MHZ+)	#24 TSPB w/ 14
5	BUS1HZ_P	1PPS Clock (1CLK1HZ+)	#24 TSPB w/ 15
6	BUSSCMD_P	Command (BUS_SCMD+)	#24 TSPB w/ 16
7	BUSREADY_P	SC Ready Signal (BUS_READYN+)	#24 TSPB w/ 17
8	N.C	Unused	NC
9	N.C	Unused	NC
10	N.C	Unused	NC
11	IDPUTLM_N	Slow Telemetry (IDPU_STLM-)	#24 TSPI w/ 1
12	IDPUSTROBE_N	High-Speed Data Clock (IDPU_STROBEN-)	#24 TSPI w/ 2
13	IDPU_DATA_N	High-Speed Data (IDPU_DATA-)	#24 TSPI w/ 3
14	BUS8MHZ_N	8.38 MHz Clock (CLK8MHZ-)	#24 TSPB w/ 4
15	BUS1HZ_N	1PPS Clock (CLK1HZ-)	#24 TSPB w/ 5
16	BUSSCMD_N	Command (BUS_SCMD-)	#24 TSPB w/ 6
17	BUSREADY_N	SC Ready Signal (BUS_READYN-)	#24 TSPB w/ 7
18	N.C	Unused	NC
19	N.C	Unused	NC
20	Chassis Ground	Chassis Ground	#24
21	N.C	Unused	NC
22	N.C	Unused	NC
23	Signal Ground	Signal Ground	#24 TP w/ 24
24	BUSSUNPULSE	Sun Pulse	#24 TP w/ 23
25	N.C.	Unused	NC
26	N.C	Unused	NC

TSPB is a twisted-shielded pair with shield terminated at the Probe Bus end.
TSPI is a twisted shielded pair with shield terminated at the IDPU end.
TP is twisted pair.

4.4 Data Interchange Specification

In this document, a Byte is an 8-bit quantity. Multi-byte integers are transmitted Most Significant Byte first unless otherwise specified.

4.4.1 Command Interface

The probe shall transmit to the IDPU a periodic synchronization command over the Command Interface once per second containing a fixed size block of data. This transmission shall start between 0ms and 100ms after the 1Hz Clock pulse, and shall complete in no more than 500 ms. The transmission shall include a probe status segment, and a command segment. The command block format is detailed below.

Table 4-4: Command Block Format

16 bytes	1008 bytes
Probe Status Segment	Command Segment

4.4.1.1 Probe Status Segment

The Probe status segment includes information on the status of the probe bus, generated automatically on board by the probe processor. The segment format is shown below .

Table 4-5: Probe Status Segment Format

6 bytes	10 bytes
Time field	Status field

4.4.1.1.1 Time

The Time field is the probe clock time in UTC (4 bytes plus 2 bytes of sub seconds) at the time of the next 1Hz clock tick. This is ordered MSB first.

4.4.1.1.2 Status Field

The Status field consists of 10 bytes of data indicating Probe status to the IDPU. The definition of the Status field is shown below.

Table 4-6: Probe Status Field Definition

Byte	**Value**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	Status Flags	Power Down	Xmitter On	Maneuver	Low Power	Battery	spare	spare	spare
2	LVPS_SCTemp	T7	T6	T5	T4	T3	T2	T1	T0
3	IDPU_SCTemp	T7	T6	T5	T4	T3	T2	T1	T0
4	SPB_SCTemp	T7	T6	T5	T4	T3	T2	T1	T0
5	SST_SCTemp	T7	T6	T5	T4	T3	T2	T1	T0
6	IDPU Current	C7	C6	C5	C4	C3	C2	C1	C0
7	Actuator Current	C7	C6	C5	C4	C3	C2	C1	C0
8	Primary Htr Current	CS7	CS6	CS5	CS4	CS3	CS2	CS1	CS0
9	Secondary Htr Current	CS7	CS6	CS5	CS4	CS3	CS2	CS1	CS0
10	Checksum	CS7	CS6	CS5	CS4	CS3	CS2	CS1	CS0

Status Flag definitions are as follows:

Bit 7 – Power Down Imminent Flag
Bit 6 – Transmitter On Flag
Bit 5 – Maneuver in Process Flag
Bit 4 – Probe is in Low Power mode
Bit 3 – Probe is in Eclipse

The Checksum is the sum of the 9 bytes above it.
Thermistor 1-4 values are 2's complement integer representing the 8 MSB's of the 14-bit A/D conversion (see Table 4-7).
Current values are unsigned integer values with a maximum measurable current and resolution as defined below.

Measurement	Maximum (mA)	Resolution mA
IDPU Current	1530	6
Actuator Current	3060	12
Primary Htr Current	2040	8
Secondary Htr Current	2040	8

Table 4-7: Probe 8-bit Temperature Conversion Definition

Temperature (°C)	Telemetry Value
–60	253
–59	253
–58	253
–57	253
–56	253
–55	252
–54	252
–53	252
–52	252
–51	252
–50	252
–49	251
–48	251
–47	251
–46	251
–45	251
–44	250
–43	250
–42	250
–41	249
–40	249
–39	249
–38	248
–37	248
–36	248
–35	247
–34	247
–33	246
–32	246
–31	245
–30	245
–29	244
–28	243
–27	243
–26	242
–25	241
–24	240
–23	240
–22	239
–21	238
–20	237
–19	236
–18	235
–17	234
–16	233
–15	231
–14	230
–13	229
–12	228
–11	226
–10	225
–9	223
–8	222
–7	220
–6	218
–5	216
–4	215
–3	213
–2	211
–1	209
0	207
1	204
2	202
3	200
4	198
5	195
6	193
7	190
8	187
9	185
10	182
11	179
12	176
13	173
14	170
15	167
16	163
17	160
18	157
19	153
20	150
21	147
22	143
23	139
24	136
25	132
26	128
27	125
28	121
29	117
30	113
31	109
32	105
33	101
34	97
35	93
36	89
37	85
38	82
39	78
40	74
41	70
42	66
43	62
44	58
45	54
46	50
47	46
48	42
49	39
50	35
51	31
52	27
53	24
54	20
55	17
56	13
57	10
58	6
59	3
60	0

4.4.1.2 Command Segment

This segment contains the instrument real-time command packets that were received by the probe in the previous second and time-tagged commands that were scheduled for execution in the previous second. The probe shall copy all instrument command packets into this buffer sequentially, with the unused portion at the end being filled with a zero fill data pattern. Instrument commands are identified by having APIDs over 400 Hex.

Commands shall be limited to 1000 bytes in length. In the unlikely event that the buffer gets full, the unsent commands are lost, and an error is reported in the probe telemetry. Only full commands shall be included in the Command Segment, no partial commands. The probe forwards command packets to the IDPU with the format described below.

Table 4-8: Command Packet Format

Format	Length	Description
0 0 0 1 1 1 0 0	1	Version=000, Type=1, Secondary Header=1, Apid="4xx"
0 0 0 0 0 0 0 0	1	Apid=400 for Command Strings
1 1 0 0 0 0 0 0	1	Packet Sequence Control = 0xC000
0 0 0 0 0 0 0 0	1	
0 0 0 0 0 0 0 0	1	Application Data Field length (less 1) = "n" (ms byte first)
n n n n n n n n	1	
0 0 0 0 0 0 0 0	1	
p p p p p p p p	1	Function Code 'p'
Byte #0	1	Data Area
Byte #1	1	
Byte #2	1	
Byte #n+1	1	
c c c c c c c c	1	Checksum* of Application Data Field = "c". (ms byte first)
c c c c c c c c	1	

Example: 1C 00 C0 00 00 07 00 01 34 12 22 11 00 7A

APID = 400H, pp=01, Length is 8-1=07, Commands are 1234H, 1122H Checksum is 007A.

*The Checksum is a 16-bit sum of bytes (“octets”) in the non-checksum portion of the packet’s Source Data Field only.

4.4.2 Low Speed Telemetry Interface

The IDPU transmits several types of packets to the probe over the Low Speed Telemetry Interface. The probe shall preserve the packet structure and type of IDPU packets (and not mix data from IDPU packets with probe data). The IDPU shall transmit to the probe a fixed-size "Housekeeping Telemetry Block" of data once per second over the Low Speed Telemetry interface. This transmission shall start between 740ms and 760ms after the 1Hz Clock pulse, and shall complete in no more than 40ms. The transmission shall include Instrument State of Health (SOH), Memory Dump (MEM), or Flux Gate Magnetometer (FGM) packets. The Housekeeping Telemetry Block format is detailed in Table 4-9: **Housekeeping Telemetry Block Format**.

Table 4-9: Housekeeping Telemetry Block Format

128 bytes
SOH, FGM, MEM Packet

4.4.2.1 State Of Health and Memory Dump Packet

The State Of Health data packet (SOH1 and SOH2) includes core system and instrument health and safety engineering data. The format of the SOH packet is found in Table 4-10: **SOH1 and SOH2 Packet Format**.

Table 4-10: SOH1 and SOH2 Packet Format

Format	Length	Description
0 0 0 0 1 1 0 0	1	Version=000, Type=0, Secondary Header=1, Apid 4xx
0 0 0 0 0 1 0 0 0 0 0 0 0 1 1 0	1	Apid=404 for SOH1 (IDPU Core System Status, Voltage, Currents) Apid=406 for SOH2 (Instrument Status)
1 1 c c c c c c	1	Packet Sequence Control = 11B
c c c c c c c c	1	APID Counter Field = 'c' counts each APID separately
x x x x x x x x	1	Application Data Field length (less 1) = xxx
x x x x x x x x	1	
Clock MS Byte	1	Secondary Header Format
Clock	1	
Clock	1	
Clock (LS Byte)	1	
Subsecs (MSB)	1	
Subsecs (LSB)	1	
Data	116	Housekeeping Data

The Memory Dump data packet MEM includes data from the IDPU memory for diagnostic purposes. The MEM data packet is provided on command only. The format of the MEM packet is found in Table 4-11: **Memory Dump Packet Format**.

Table 4-11: Memory Dump Packet Format

Format	Length	Description
0 0 0 0 1 1 0 0	1	Version=000, Type=0, Secondary Header=1, Apid > 4xx
0 0 0 0 0 1 1 1	1	Apid=407 for MEM (Diagnostic Memory Dump Packet)
1 1 c c c c c c	1	Packet Sequence Control = 11B.
c c c c c c c c	1	APID Counter Field = 'c' counts each APID separately.
x x x x x x x x	1	Application Data Field length (less 1) = xxx
x x x x x x x x	1	
Clock MS Byte	1	Secondary Header Format
Clock	1	
Clock	1	
Clock (LS Byte)	1	
Subsecs (MSB)	1	
Subsecs (LSB)	1	
CMDUMPSTADD	4	ULI085: Start Address of Dump
CMDUMPENDADD	4	ULI085: End Address of Dump
CMDUMPPKTADD	4	ULI085: Address where data in this packet begins
CMDUMPPKTSIZ	2	UI085: Number of bytes of data in this packet
CMDUMPCNUM	1	UB: Which copy does this packet belong with
CMDUMPCTOT	1	UB: How many copies were requested
0	1	
0	1	
Byte #0	98	Data Area
Byte #1		
Byte #2		

4.4.2.2 Flux Gate Magnetometer Packet

The Flux Gate Magnetometer (FGM) data packet includes 18 samples of vector X,Y,Z data from the Instrument's Flux Gate Magnetometer. The FGM packet will be enabled, disabled or filtered into the spacecraft memory as needed. The format of the FGM packet is found in Table 4-12: **FGM Packet Format**.

Table 4-12: FGM Packet Format

Format	Length	Description
0 0 0 0 1 1 0 0	1	Version=000, Type=0, Secondary Header=1, Apid 4xx
0 0 0 0 0 1 0 1	1	Apid=405 for FGM
1 1 c c c c c c	1	Packet Sequence Control = 11B
c c c c c c c c	1	APID Counter Field = 'c' counts each APID separately
x x x x x x x x	1	Application Data Field length (less 1) = xxx
x x x x x x x x	1	
Clock MS Byte	1	Secondary Header Format
Clock	1	
Clock	1	
Clock (LS Byte)	1	
Subsecs (MSB)	1	
Subsecs (LSB)	1	
XXXX YYYY	1	XXXX, YYYY are the Range Bits for the X and Y axes
ZZZZ 0 T T T	1	ZZZZ Range Bits for the Z axis; TTT = 0-5 mean 4,8,16,32,64,128
FGM-X (MSB)	1	Fluxgate X
FGM-X	1	
FGM-Y (MSB)	1	Fluxgate Y
FGM-Y	1	
FGM-Z (MSB)	1	Fluxgate Z
FGM-Z	1	
Repeat Vectors	90	Fluxgate X,Y,Z data
Spare	18	

4.4.3 High Speed Telemetry Interface

The high-speed telemetry interface shall be used to transfer CCSDS-formatted instrument telemetry frames as described in THM-SYS-115 THEMIS Telemetry Format Specification. (The DCB starts clocking out bits at the Version Number and ends at the last bit of the Operational Control Field. The BAU will overwrite certain fields however, such as the Spacecraft ID, the Master Channel Frame Count, Transfer Frame Time Code, and the Operational Control Field).

4.4.3.1 High Speed Telemetry Protocol

This section defines how the BAU and DCB collaborate to transfer “high speed” IDPU data from the DCB to the BAU. A timing diagram of the related signals is given in section 4.2.5.

The high-speed telemetry (HST) interface transfers data in a single direction, from the IDPU to the BAU. Both the BAU and the IDPU must be enabled, by command, to participate in a transfer session. The ordering of the enabling commands is immaterial.

The flow of data is not continuous; rather, it’s broken into discrete transfers. Each such transfer is a “Transfer Frame” as defined in section 3 of the THEMIS Telemetry Data Format Specification, file “thm_sys_115*”. The Transfer Frame has no Sync Word or Reed Solomon Block; that is, it is not a Master Frame.

The BAU controls each transfer by asserting its READYN signal. If the IDPU has been enabled for HST transmission, it will send exactly one Transfer Frame, starting within 5 microseconds of the READYN assertion (conservative value). When the BAU begins a transfer, it also starts a timeout counter with a BAU-programmable duration of at least 4.62 milliseconds. This duration represents 110% or more of the time to transfer a frame. The transfer interval ends when either the expected number of bits has arrived or when the timeout clock expires. The BAU marks the end of a transfer by deasserting READYN.

A transfer session can be terminated by a command to either the BAU or IDPU. In either event, the actual sequencing ends after the present frame has completed its passage between the units.

The time between transfers can be as short as 1 microsecond but the maximum time is unconstrained (the BAU may have been disabled, for example). The transfer bit rate between the IDPU and the BAU is just over 2 MHz (2 ^ 21 Hz) but the downlink bit rate can be as low as 1 kHz or as high as 1 MHz. This means a typical delay between transfers will be a “frame time”, about 4.2 milliseconds. Thus a typical duty cycle is about 50% but the maximum over short bursts can be nearly 100%.

The time from the deassertion of READYN to the assertion of READYN is variable due to BAU internal activities (like buffer management, delays encountered while transmitting higher priority (VC0, VC1) frames). See table in section 4.2.5.

Both the BAU and the IDPU count the bits being transferred. Though it’s highly unlikely that their counts would disagree, the following details the recoveries in case such problems arise. The cases to examine:
- The BAU thinks it’s counted all the bits in a frame but the IDPU thinks there are more to go.
- The IDPU thinks it’s sent all the bits but the BAU thinks more bits are needed.
- The BAU detects no bits during the READYN interval and times out. The IDPU sent no data.

If the BAU times out but some bits have been detected, the BAU shall:

a. Deassert READYN (as normal for a timeout)
b. fill in S/C Identity, time field, Master frame count, & Oper Ctl field as for a normal frame
c. transmit the frame, as normal.
d. count the error.

If the BAU times out but no bits have been detected, the BAU shall:

e. Deassert READYN (as normal for a timeout)
f. Reassert READYN after a delay time, T8, defined in section 4.2.5

If the IDPU thinks it has sent all the data for a frame but the BAU is still waiting for more bits, the IDPU will not generate fill data; it will just let the BAU time out as described above.

The DCB will not attempt a transfer if data becomes ready only during a READYN cycle (that would invite a timeout). The IDPU software must first declare data to be ready to the HST unit, a portion of the DCB Actel (FPGA). When the next READYN is asserted, a transfer is made.

4.4.4 IDPU Fill Packet

When a packet terminates during an ongoing frame transmission, and the IDPU has no more data to send, the following 8 byte pattern ("IDPU Fill Packet") is sent repeatedly to fill the frame: 0x07, 0xFF, 0xC0, 0x00, 0x00, 0x01, 0xCA, 0x95

Note: Although the fill pattern always begins with the first byte (0x07), it may terminate on either four byte boundary (ending the frame with either 0xC0, 0x00, or 0xCA, 0x95).

According to the Themis Packet Telemetry definition, this Hardware Fill Packet represents a packet with ApID = 0x7FF and a length field of 1 (implying two bytes of data beyond the packet header). The ApID Counter Field is always set to zero.

4.5 EMI/EMC Issues

This section lists significant and unusual EMC concerns for the instrument.

4.5.1 Grounding

The instrument grounding plan is shown in Reference 4. The IDPU chassis is connected to IDPU Box through plated screw hole on DCB and jumpered to signal ground on the DCB. The IDPU/ESA assembly is electrically isolated. The IDPU chassis ground is connected to Probe chassis at a single point.

4.5.2 IDPU VME Chassis

The IDPU chassis processes very sensitive signals, and should be kept away from noise sources. The box is fairly well sealed, but may be sensitive to high frequency magnetic coupling.